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SUSTAINABILITY LOGISTICS BASING – SCIENCE AND TECHNOLOGY OBJECTIVE – DEMONSTRATION; 50, 300, 1000-PERSON BASE CAMP, ANALYSIS OF FY12 OPERATIONALLY RELEVANT TECHNICAL BASELINE

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14. ABSTRACT

This report documents the efforts of the U.S. Army Natick Soldier Research, Development and Engineering Center's Sustainability/Logistics-Basing -Science and Technology Objective – Demonstration to analyze the FY12 Operationally Relevant Technical Baseline for 50, 300, and 1000-Person Basecamps. This technical baseline establishes a benchmark for the analysis of materiel and non-materiel solutions that could reduce fuel and water consumption as well as generation and back-haul of waste in basecamps.

15. SUBJECT TERMS

COSTS	SAVINGS	REDUCTION	ENVIRONMENTS	MAINTAINABILITY
FUELS	METRICS	COMPLEXITY	SUSTAINABILITY	CONTINGENCY BASES
WASTE	LOGISTICS	WASTE WATER	WASTE DISPOSAL	REDUCED FOOTPRINT
WATER	BASE CAMPS	BENCHMARKS	QUALITY OF LIFE	CONTINGENCY BASING
POWER	BASE LINES	TECHNOLOGY	DATA COLLECTION	QOL(QUALITY OF LIFE)
ENERGY	MANPOWER	SOLID WASTES	WASTE REDUCTION	FUEL DEMAND REDUCTION
				WATER DEMAND REDUCTION

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Executive Summary

The report covers work done for the Sustainability Logistics Basing – Science and Technology Objective – Demonstration (SLB-STO-D) [1] from the period of January 2012 to November 2016.

In 2010, the Army recognized the need to reduce sustainment demands at contingency bases. Contingency bases are highly dependent on resupply, which can be unpredictable, put Soldiers at risk in convoys, and impact mission completion. It is too costly, labor intensive for a small unit (platoon, company, and battalion) to transport, and maintain all required consumables (fuel and water) to last for weeks or months at small basecamps. In 2011, the US Army Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology charged the Research Development and Engineering Command (RDECOM) with conducting a Technology Enabled Capability Demonstration (TECD) 4a - Sustainability/Logistics—Basing (SLB), now programmed as a Science & Technology Objective – Demonstration (STO-D) to develop, collaborate, and execute a program that would address these sustainment challenges.

> *The Army needs improved capability to enable sustainment independence by reducing resupply and backhaul demand at contingency basecamps. The FY12 through FY17 objective is to reduce the need for fuel resupply by 25%, reduce the need for water resupply by 75%, and decrease waste generation/backhaul by 50% while maintaining a Force Provider like Operational Quality of Life (QoL-(O)) at these basecamps.*

Current Army maneuver units have limited or no organic basing capability and rely on theater provided support. Except for Force Provider, the majority of theater provided equipment/support is not standardized, integrated, or optimized to be easily deployed, transported, or erected and is inherently inefficient. The problem mentioned above forms the basis for the program, lays the foundation for the formulation of the program execution plan, and is pervasively present in the program baseline.

The challenge is to formulate an integrated Model Based Systems Engineering approach for both technologies and non-materiel solutions to address current Army contingency basing barriers. The SLB-STO-D program uses modeling, simulation and analysis to show a reduction in fuel resupply by 25%, a reduction in water resupply by 75%, and a reduction of 50% in waste generated for backhaul at basecamps compared to an established technical and operational baseline, while maintaining a Force Provider-like (QoL (O)). The focus of the SLB-STO-D program is on the 50, 300, and1,000 personnel basecamps, on which the Army's Science and Technology (S&T) efforts are most likely to have a greater impact in resource reduction.

The work was performed in collaboration with a number of organizations, including:

- US Army Corps of Engineers – Engineering Research Development Center – Construction Engineering Research Laboratory (ERDC – CERL)
- US Army Natick Soldier Research, Development, and Engineering Center (NSRDEC)

[1] Formerly known as Technology-Enabled Capability Demonstration 4a (TECD 4a) Sustainability/Logistics-Basing.

- US Army Communications-Electronics Research, Development, and Engineering Center (CERDEC)
- Tank Automotive Research, Development, and Engineering Center (TARDEC)
- Product Director Contingency Basing Infrastructure (PdD – CBI)
- Product Manager Force Sustainment Systems (PdM – FSS)
- Army Materiel Systems Analysis Activity (AMSAA)
- Maneuver Support Center of Excellence (MSCoE)
- Sustainment Center of Excellence (SCoE)
- Combined Arms Support Command (CASCOM)

The FY12 Operationally Relevant Technical Baseline (ORTB) is based on the FY12 basecamp technologies used at the inception of the SLB-STO-D program. The SLB-STO-D's problem space was defined in 50, 300, and 1000 personnel (PAX) representative baseline basecamps and the applicable operational use cases. The data from the baseline basecamps was used in modeling simulation programs to determine and analyze FWW parameters. Relevant data and documentation were used to support resource simulation at the three representative baseline basecamps in a desert, temperate, and tropical expeditionary environments.

This report covers the simulation results of the baseline basecamps as documented in the ORTB. The primary purpose of the baseline results analysis is to provide a basis of comparison for identifying the impacts of the integration of various materiel and non-materiel solutions into the basecamp. The secondary purpose of the analysis is to provide insight from the functional breakdown of the resource usage to guide the development efforts of materiel and non-materiel integration. The analysis will assist in determining functional areas with significant contributions to the overall resource consumption of the basecamp, which in turn will provide the focus for future analysis.

Key insights of this analysis are:

- 80-90% of fuel usage on basecamps is due to power generation.
- Power reduction does not have a one-to-one reduction with fuel due to the generator's fuel consumption in an idle state. Power generation on the supply side must be addressed along with reducing power demand to achieve the SLB-STO-D objective of 25% fuel reduction.
- 47-60% of power consumption on the basecamp is due to shelter heating and cooling. This should be the primary target for power reduction.
- Two facilities have larger than 25% contributions to the water usage on the basecamp: showers and latrines. Both facilities must have decreased water demand or net usage reduction for the SLB-STO-D objective of 75% water demand reduction to be achieved.
- The primary wastewater contributors are the same facilities, shower and latrines, as the water demand contributors. Waste can be addressed through reduction on the demand side, recycling, or treatment for on-site disposal. All three options should be explored to achieve the SLB-STO-D objective of 50% waste reduction.

The report captures a recommendation to continue future efforts that build upon the insights captured herein and to assess the impact of the integration of various materiel and non-materiel

solutions into the ORTB basecamps against these same metrics. Moreover, while fuel and water consumption, waste generation, and Soldier Operational Quality of Life (QoL (O)) are key metrics in the design and sustainment of a basecamp, several other attributes contribute to the success of basecamps. These attributes include reliability, availability, maintainability, cost, manpower, complexity, footprint, and many others. An opportunity exists to establish a baseline of these attributes for the ORTB basecamps, which would allow for the analysis of materiel and non-material solutions across these dimensions.

SUSTAINABILITY LOGISTICS BASING – SCIENCE AND TECHNOLOGY OBJECTIVE – DEMONSTRATION; 50, 300 & 1000-PERSON BASECAMP, ANALYSIS OF FY12 OPERATIONALLY RELEVANT TECHNICAL BASELINE

1. INTRODUCTION

The technical report documents the baseline results for a simulation performed by the Sustainability Logistics Basing – Science and Technology Objective – Demonstration (SLB-STO-D) Program from January 2012 to November 2016. The SLB-STO-D is a Department of the Army funded Research, Development and Engineering Command (RDECOM) managed program.

The simulation provided information about the fuel resupply needed, water resupply needed, and waste generated for backhaul for 50, 300, and 1000 personnel (PAX) basecamps in expeditionary environments. The 50, 300, and 1000 PAX basecamps are intended to be a representative of the FY12 basecamps and the technologies, equipment, systems, and standards used at the time. Development of the FY12 basecamps was led by the SLB-STO-D Program and in collaboration with a number of other organizations, including:

- US Army Corps of Engineers – Engineering Research Development Center – Construction Engineering Research Laboratory (ERDC – CERL)
- US Army Natick Soldier Research, Development, and Engineering Center (NSRDEC)
- US Army Communications-Electronics Research, Development, and Engineering Center (CERDEC)
- Tank Automotive Research, Development, and Engineering Center (TARDEC)
- Product Director Contingency Basing Infrastructure (PdD – CBI)
- Product Manager Force Sustainment Systems (PdM – FSS)
- Army Materiel Systems Analysis Activity (AMSAA)
- Maneuver Support Center of Excellence (MSCoE)
- Sustainment Center of Excellence (SCoE)
- Combined Arms Support Command (CASCOM)

MSCoE and CASCOM provided significant subject matter expert (SME) input and were the executive agents for the Operationally Relevant Technical Baseline (ORTB).

1.1 SLB-STO-D Program

In 2010, the Army recognized the need to reduce sustainment demands at contingency bases. Contingency bases are highly dependent on resupply, which can be unpredictable, put Soldiers at risk in convoys, and impact mission completion. It is too costly and labor intensive for a small unit (platoon, company, and battalion) to transport and maintain all required consumables (fuel and water) to last for weeks or months at small basecamps. In 2011, the US Army Office of the

Assistant Secretary of the Army for Acquisition, Logistics, and Technology charged the Research, Development and Engineering Command (RDECOM) with conducting a Technology Enabled Capability Demonstration (TECD) 4a – Sustainability/Logistics—Basing (SLB), now programmed as a Science & Technology Objective – Demonstration (STO-D) to develop, collaborate, and execute a program that would address these sustainment challenges.

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Current Army maneuver units have limited or no organic basing capability and rely on theater provided support. Except for Force Provider, the majority of theater provided equipment/support is not standardized, integrated, or optimized to be easily deployed, transported, or erected and is inherently inefficient. The above-mentioned problem statement forms the basis for the program, lays the foundation for the formulation of the program execution plan, and is pervasively present in the program baseline.

The challenge is to formulate an integrated Model Based Systems Engineering (MBSE) approach for both technologies and non-materiel solutions to address current Army contingency basing barriers. The SLB-STO-D program uses modeling, simulation, and analysis to show a reduction in fuel resupply by 25%, a reduction in water resupply by 75%, and a reduction of 50% in waste generated for backhaul at basecamps compared to an established technical and operational baseline, while maintaining a Force Provider-like (QoL (O)). The focus of the SLB-STO-D program is on the 50, 300, and 1,000 personnel basecamps, on which the Army's Science and Technology (S&T) efforts are most likely to have a greater impact in resource reduction.

1.2 FY12 Operationally Relevant Technical Baseline (ORTB) Concept

The SLB-STO-D defined the problem space by documenting FY12 50, 300, and 1,000 PAX representative baseline basecamps (FY12 ORTB basecamps) and the applicable operational use cases [1, 2, 3]. The FY12 ORTB basecamps are a characterization of the aggregate or most commonly equipped basecamps up to FY12. Extensive data and documentation was captured to support resource simulation at the three representative basecamps in desert, temperate, and tropical expeditionary environments. Three yearlong temperature profiles were specified, in addition to supporting documentation on how weather impacts component usage. Basis of estimation also includes derivations of basecamp attributes, such as convenience outlets, solid waste generation, and storage infrastructure.

The FY12 ORTB provides the appropriate detail to support simulations of the three representative baseline basecamps and high fidelity documentation that includes:

- Three Operational Orders
- Operational Use Cases

- Dimensionally accurate Basecamp Layouts
- Complete listings of facilities and components with assumptions as to how each facility is used
- Supporting documentation on how weather would impact component usage
- Basis of estimation for basecamp attributes, such as convenience outlets, solid waste generation, and storage infrastructure

To ensure the accuracy and operational relevance of the FY12 ORTB, the following sources were consulted during its creation:

- Baseline camp configurations
- Best practices and challenges provided by SMEs
- Tactics, Techniques and Procedures
- Capabilities-Based Assessment
- Initial Capabilities Documents
- Functional Area Analysis, Functional Needs Assessment, and Functional Solutions Analysis
- Numerous S&T led user assessments
- Theater Standard Operating Procedures
- Reports from small units through their chain of command up to the Department of the Army

Figure 1 shows a High Level Operational Concept (OV-1)[1] for the three representative baseline basecamps. The OV-1 provides an overview of each basecamp with its high-level capabilities and features. The 50 PAX basecamp key features include highly mobile, limited life support capabilities and an equipment set allowing for 100% organic support. The 300 PAX basecamp key features include expanded functions compared to the 50 PAX basecamp. The 300 PAX equipment set is mobile and is highly adaptable, allowing for scalable life support services. The 1000 PAX basecamp equipment set is less mobile than the 300 PAX equipment, offering a high level of services requiring some level of contractor support.

[1] OV-1 is also known as an Operational View

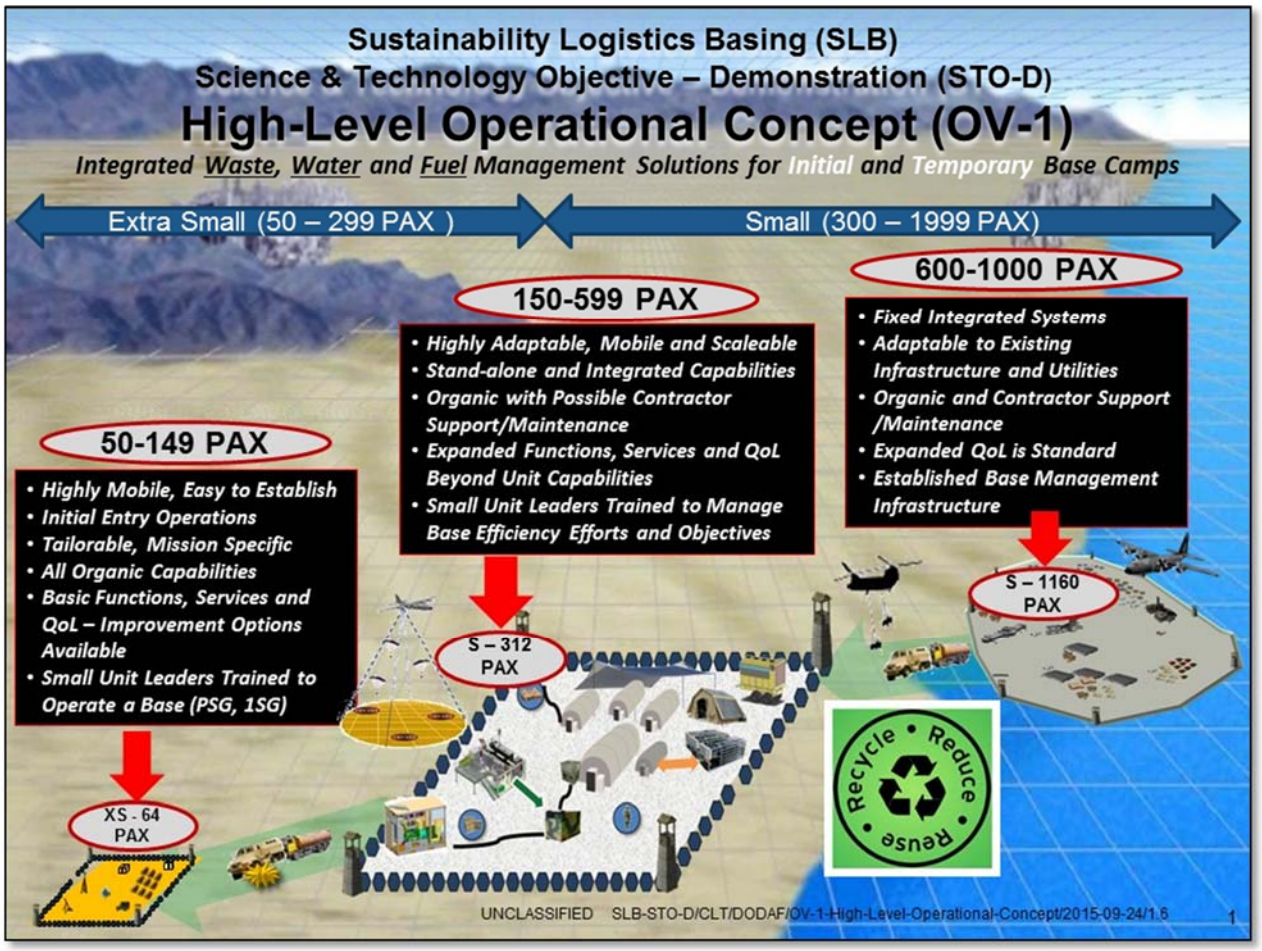

Figure 1: FY12 ORTB High Level Concept

The focus of the report is to document the simulation results of the three baseline basecamps and provide analysis insights. Once quantitatively defined, the FY12 fuel and water consumption and waste generation metrics can be used as a benchmark for comparison to simulated scenarios utilizing technologies introduced to address the challenge areas. Analysis can be conducted on these results, focusing future efforts to reduce fuel, water, and waste. The FY12 ORTB (FY 2012 Equipment, Systems and Standards) is a key artifact for the SLB-STO-D Analytical Framework (**Figure 2**).

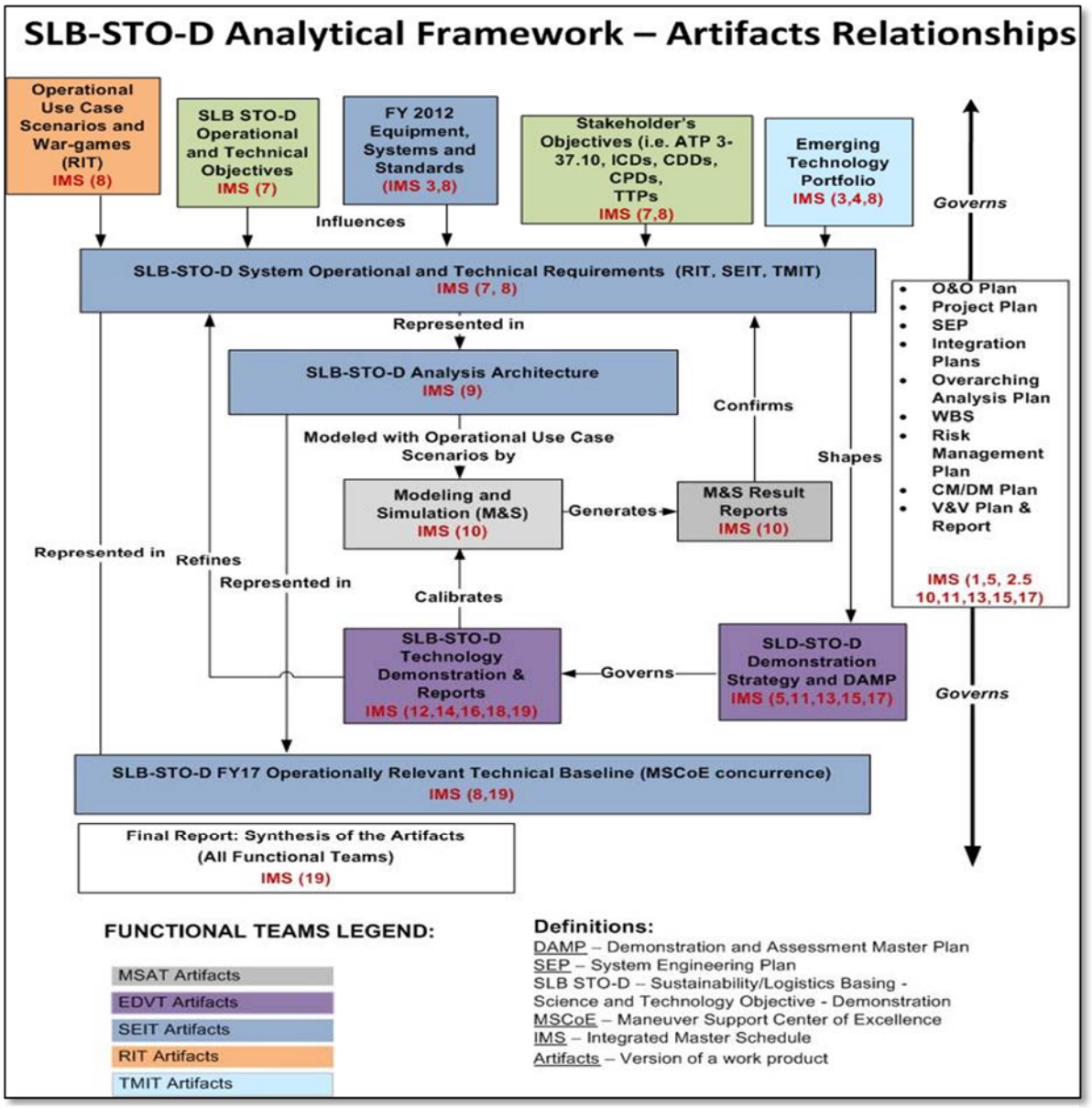

Figure 2: SLB-STO-D Analytical Framework

The Analytical Framework provides a high-level visual representation of the SLB-STO-D System Engineering Plan and organizes analysis into an MBSE framework that identifies the relationships between the analytical artifacts and how they fit together systemically to accomplish the SLB-STO-D objectives. The MBSE process starts with the FY12 ORTB, which helps define the Analysis Architecture [4] that determines the associated fuel and water consumption and waste generation factors. In the future, these results can be used to determine if the proposed materiel and non-material solutions provide a significant reduction of fuel, water or waste that could meet the SLB-STO-D's reduction objectives.

1.3 FY12 ORTB Report Objectives

The specific objectives for the FY12 ORTB Report were:

- Enable quantitative comparison of potential materiel and non-materiel basecamp solutions to the FY12 baseline.
- Focus future basecamp analysis by identifying top camp-level and equipment-level consumers of fuel and water and generators of waste.
- Provide the basecamp community with high-level conclusions and insights from the FY12 300 PAX baseline.
- Ensure simulation results are understood by a broad basecamp community so they can be used outside of the SLB-STO-D.
- Serve as a method to document baseline results and baseline input products for configuration control purposes.
- Focus on the FY12 ORTB 300 PAX Ready State as a good representation of modeling insights, methods, and tools used and, if desired, point reader to further documentation and results from the 50 and 1000 PAX ORTBs used by the SLB-STO-D.

2. ANALYSIS PURPOSE AND APPROACH

This chapter determines the metrics of fuel and water consumption, waste generation, and QoL(O) and decomposes the ORTB basecamp into functional areas, individual facilities, and components for modeling purposes. The chapter also considers the documentation, data, and tools that were used for the analysis.

2.1 Analysis Purpose

The purpose of this analysis is to determine fuel and water consumption, waste generation, and QoL (O) metrics for a representative army basecamp at three different sizes—50, 300, and 1000 PAX. The analysis will provide valuable insights to be applied to the integration of materiel and non-materiel solutions to reduce the fuel demand by 25%, water demand by 75%, and waste generated for backhaul by 50% while maintaining a similar level of Force Provider-like QoL(O) on the basecamp.

This report covers the simulation results of the baseline basecamp as documented in the ORTB. As previously stated in the report objectives, the baseline results will be utilized for several purposes. The primary purpose of the baseline results analysis is to provide a basis of comparison for identifying the impacts of the integration of various materiel and non-materiel solutions into the basecamp. The secondary purpose of this analysis is to provide insight from the functional and system breakdown of the resource usage to guide development efforts of materiel and non-materiel integration. This analysis will assist in determining functional and system areas with significant contributions to the overall resource consumption of the basecamp, which in turn will provide the focus for future analysis.

2.2 Analysis Approach and Methodology

Modeling a basecamp is a very challenging problem. To model the basecamp in an organized manner, it was first decomposed into functional areas such as *Provide Billeting*, *Provide Latrine Services* and *Provide Subsistence*. These functional areas were then decomposed into individual facilities, such as billeting tents, latrines, and kitchens. All the facilities are identified in the ORTB documentation. Each facility was then further decomposed into a collection of individual components, such as a shelter, environmental control unit (ECU), and lights. Each facility definition includes the composition, quantity, connections, and hours of operation of these components. For a list of equipment simulated, see ANNEX A. The layout for each base camp are provided in ANNEX B.

Numerous models were developed to cover all the identified individual components of the basecamp. The simplest of models uses a constant resource flow for every hour of the simulation. Some of the models require an interaction with the environment, such as temperature or humidity, as an input. Other models utilize a usage event dependent upon the number of people on the basecamp and how often the event happens. For example, a hot meal usage event was used for the kitchen model to determine how much power, fuel, and water was consumed and how much waste was generated.

Each individual component is mapped to a model type as well as the component's respective inputs to the model, the sources of data or information use to define the inputs of the model, and the assumptions and limitations of the component. The inputs applied for each component were thoroughly researched to determine the best value to be used. In each case, the input was defined using the best source of data available at the time of development. These sources include measured data from demonstrations, measured data from formal testing, manufacturers' specifications, and SME input. The documentation for each component has full traceability to the inputs and sources, and enables future updates based on availability of new or improved sources of data.

The component models are integrated in a software tool known as the Detailed Component Analysis Model (DCAM), co-developed by the SLB-STO-D and ERDC-CERL. DCAM is also used as a sub-module of the Virtual Forward Operating Base (VFOB) suite of tools developed by ERDC-CERL. DCAM is a flexible and reconfigurable simulation environment that can be used to simulate basecamps at many different sizes, which can be made up of different types of systems.

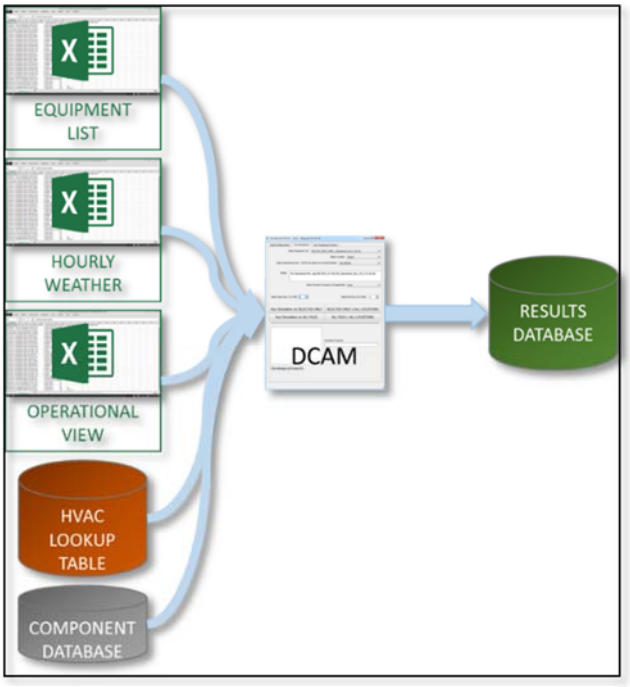

Figure 3: DCAM Software Tool

Sample simulations were run in DCAM to verify that the models worked as expected. As shown in (**Figure 3**), the DCAM tool requires a set of spreadsheet inputs and two reference databases to simulate a given configuration at a 1-h time step for up to a 1 year duration. The Equipment List spreadsheet is the principal input to DCAM that defines the basecamp that is to be simulated and is developed based upon the facilities identified in the ORTB documentation. The system configuration file (a precursor to the Equipment List) documents the facilities that make up the basecamp and their connections. The baseline system configuration files were then simulated using DCAM. The simulations were run for a 1-year period to ensure all seasonal variations were captured and accounted for across three environments—Desert, Temperate, and Tropical. These three environments were chosen to show the impacts of weather across the three most common environments in which basecamps are established. The fuel, water, and waste results were averaged to a daily usage amount to account for seasonal differences. These results are shown in ANNEX C, and the 300 PAX Ready State use case is discussed in Chapter 3.

The QoL(O) for each of the basecamp sizes was assessed using the QoL (O) tool, developed for the SLB-STO-D program by the Consumer Research Team (NSRDEC), based upon the assumptions documented within the ORTB. A more detailed explanation of the QoL(O) tool can be found in Section 3.4 of this report.

2.3 Simulation and Analysis Documentation, Data, and Tools

The supporting documentation was developed to provide full traceability for the baseline results to the numerous data sources. There are approximately 150 component specifications, 60 facility specifications, 23 model specifications, and 23 verification reports associated with the baseline results. The baseline results were supported by the use of several tools, such as DCAM, MATLAB® Analysis Tools, and the QoL(O) tool.

The DCAM tool (**Figure 3)** uses numerous input files that include system configuration, equipment list, operational view, an hourly profile, a component database, and a lookup table database. The system configuration file documents the basecamp's facilities and connections. The equipment list file documents the basecamp at the component level instead of the facility level. The operational view file documents the basecamp's personnel and the usage events inputs to designated models. The hourly profile file documents the components within each facility and the hours of the day that represent a specific mode in the component profile (e.g., which hour it is ON or OFF). The component database contains the facilities and their defined composition as well as the components and their respective model inputs. The lookup database augments the component database by defining the model inputs for components that use an hour-by-hour lookup table for each environment. The DCAM tool has been vital to the efforts of this analysis. The configuration utilized for these results is captured in ANNEX D.

The MATLAB Analysis Tool enables the user to perform the required analysis on the results database from DCAM. The analysis includes the ability to summarize the daily average values in tabular and graphical form. The MATLAB Analysis Tools also enable the detailed analysis necessary for verification reports. The tools include the vehicle fuel model that calculates the estimated vehicle fuel usage on the basecamp for the movement of resources.

The QoL(O) tool is based on survey data from 1200 Soldiers. It breaks QoL (O) down into 84 attributes, each with various levels. The tool is used by the SLB-STO-D to quantitatively understand the QoL(O) related impacts of inserting technology or non-material changes to a basecamp. A more detailed explanation of the QoL(O) tool can be found in Section 3.4 of this report

The SLB-STO-D is responsible for the configuration management of the tools, output results, and the supporting documentation. Copies of the supporting documentation, data, and tools used in the analysis effort can be requested using the process described in ANNEX E.

3. FY12 ORTB RESULTS

The FY12 ORBT results section looks at the results of the 300 PAX baseline simulations across the desert, temperate, and tropical environments. The report only shows the 300 PAX Ready State results due to time and resource constraints; however, the same analysis process can be applied to the 50 PAX and 1000 PAX Ready State results to include the Population Variance results for all ORTB basecamps. For the results of the 50 PAX Baseline and the 1000 PAX Baseline, please refer to ANNEX C**.**

The SLB-STO-D used a Ready State and a Population Variance use case for the simulations. The Ready State baseline use case is detailed in the body of the report. The Population Variance use case can be found in ANNEX C.

The Ready State use case is defined as a basecamp that has been fully constructed and operational prior to the start of the simulation. The simulation then models the fuel and water usage and waste generation of the camp over a year timeframe. The analysis shown in ANNEX C summarizes these yearly results to a daily average. The Population Variance use case is defined as having a 30% increase in population for up to 7 days, thus placing the camp's resources in high demand. For further definition of the FY12 ORTB Operational Use Cases, please refer to the ORTB [1, 2, 3].

3.1 FY12 ORTB: Results Organization and Breakdown

The results shown for the three environments are organized into the following categories:

- Fuel, including Power Demand
- Potable Water Demand
- Waste Generation, including Waste Water Generation and Solid Waste Generation

Each of the categories above are further broken down into both basecamp level functions and equipment level functions. Basecamp level functions are defined at the facility level within the system configuration DCAM inputs files. The equipment level functions are defined at the component level within the Component Database DCAM input. All camp level functions used in the baseline system configurations are listed and described with examples in **Table 1.** All equipment level functions used for components in the baseline are listed and described with examples in **Table 2.** The results of the simulation will only show the resource-consuming functions; some of the functions defined may not be included in the actual simulation results because those functions do not account for any resource usage.

Table 1. Camp Level Function Descriptions

Camp Level Function	Description
Enable Command and Control	Facilities that enable command and control of the basecamp. These facilities include Tactical Operations Centers, Command Posts, and Tactical Command Posts.
Enable Communications	Facilities that enable communications both on the basecamp and outside of the basecamp. These facilities include the Key Leader Engagement Area on the 1000 PAX camp.
Enable Movement & Maneuver	Facilities that enable movement and maneuver both within the basecamp and outside of the basecamp. These facilities include the Quick Reaction Force Staging Area on the 1000 PAX camp.
Execute Protection	Facilities that provide and execute the protection of the basecamp. These facilities include the radar clusters, guard towers, and entry control points.
Provide Access to MWR Services	Facilities that provide Morale, Welfare, and Recreation (MWR) activities and services to the troops on the basecamp. These facilities include all MWR facilities as well as the Army and Air Force Exchange Service and Chapel.
Provide Access to Maintenance/Repair	Facilities that provide maintenance and repair services on the basecamps. These facilities include wash racks, the M7 Forward Repair System, and other maintenance facilities.
Provide Access to Medical & Health Services	Facilities that provide medical services. These facilities include aid stations.
Provide Access to Refueling	Facilities that enable vehicles to refuel. These facilities include the fuel storage tanks.
Provide Access to Transportation	Facilities that provide non-tactical transportation capabilities for support functions on the basecamp. These facilities include support vehicles.
Provide Billeting	Facilities that provide billeting of the personnel on the basecamp. These facilities include billeting shelters, both hard and soft wall.
Provide Electric Power	Facilities that provide power to the basecamp. These facilities include generators.
Provide Integrated Waste Water Management	Facilities that manage waste water within the basecamp. These facilities include waste water blivets.
Provide Integrated Water Management	Facilities that manage water across the basecamp. These facilities include water blivets.
Provide Latrine Services	Facilities that provide latrine services across the basecamp. These facilities include latrines, burn out latrines, etc.
Provide Means to Clean Clothes	Facilities that enable the basecamp personnel to have clean clothes. These facilities include laundry facilities.

Table 1. Camp-Level Function Descriptions (continued)

Camp Level Function	Description
Provide Means to Maintain Personal Hygiene	Facilities that provide personal hygiene capabilities to the basecamp personnel. These facilities include shower facilities and hand washing stations.
Provide On Base Lighting	Facilities that provide lighting on the basecamp level. These facilities include all perimeter light sets.
Provide Solid Waste Management	Facilities that manage solid waste on the basecamp. These facilities include the solid waste distributed collection facilities as well as the burn pits.
Provide Subsistence	Facilities that provide for the storage, preparation and serving of food on the basecamp. These facilities include the kitchen, food refrigeration and the dining facilities.
Warehouse/Store All Supply Classes	Facilities that provide a storage capability on the basecamp. These facilities include supply offices and tents.

Table 2. Equipment Level Function Descriptions

Equipment Level Function	Description
Communications and Computers	All components related to communications and computers. These components include laptops, printers, phones, radios, satellites, etc.
Convenience Loads	All components that are considered convenience for personnel on the basecamp. This includes personal laptops, cell phones, televisions, etc.
Food Prep and Cleaning	All components involved in food preparation and cleaning. This includes cooking components within the kitchen and cleaning components within the Food Sanitation Center.
Hygiene and Showers	All components utilized for personal hygiene. This includes showers, sinks, etc.
Latrine	All components utilized for latrine usage. This includes toilets and urinals.
Laundry	All components utilized for washing and drying personal clothing. This includes washers and dryers.
Lighting	All components utilized for lighting the basecamp. This includes light bulbs within shelters as well as guard tower spotlights.
Maintenance	All components utilized for maintenance activities on the basecamp. This includes air compressors, the wash rack and the M7 Forward Repair System.
On-camp Vehicles	All vehicle components on the basecamp. This includes trucks, fork lifts, tractors, etc.
Power Distribution	All components that distribute power throughout the basecamp. This includes all power distribution elements.
Power Generation	All components that generate power for the basecamp's needs. This includes all generators.
Protection	All components that execute protection on the basecamp. This includes guard tower cameras, radars, and vehicle gates.
Refrigeration	All components that provide refrigeration on the basecamp. This includes the Multi-Temperature Refrigerated Container System and other refrigerators.
Shelter	All components that provide shelter (soft and hard wall). This includes TEMPER (Tent, Expandable, Modular, Personnel) tents, TRICONs (triple containers), MILVANs (military shipping containers), B-Huts, etc.
Shelter Heating and Cooling	All components that provide shelter heating and cooling. This includes all environmental control units as well as fuel fired heaters.
Solid Waste Generation	All components that produce solid waste. This includes the solid waste generation component.
Store Fuel	All components that store fuel. This includes various fuel tanks and blivets.

Table 3. Equipment Level Function Descriptions (continued)

Equipment Level Function	Description
Store Noncombustible Waste	All components that store noncombustible waste. This includes dumpsters.
Store Potable Water	All components that store potable water. This includes various potable water tanks and blivets.
Store Solid Waste	All components that store solid waste. This includes dumpsters.
Store Waste Water	All components that store waste water. This includes various waste water (gray and black) tanks and blivets.
Water Heating	All components that heat water. This includes the water heater burner as well as the heat traces.
Water Pumping	All components that pump water throughout the camp. This includes all pumps.

3.2 FY12 Fuel, Water, and Waste High Level Summary

The FY12 fuel, water, and waste summary section provides a high-level summary of the basecamp level results for the 300 PAX Ready State use case as documented within the ORTB. **Table 4** contains the mean daily values for fuel, power, potable water, waste water, and solid waste. The fuel values shown do not include fuel used outside of the basecamp for missions. The water values shown do not include water for human consumption. The waste water and solid waste generated is assumed to be backhauled and not disposed of onsite.

Table 4: Camp Level Summary, 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Fuel Demand (Mean gal/day)	1042	1096	1023
Power Demand (Mean kWh/day)	5108	4091	4806
Potable Water Demand (Mean gal/day)	8723	8723	8723
Waste Water Generation (Mean gal/day)	8529	8529	8529
Solid Waste Generation (Mean lb/day)	2870	2870	2870

As shown in **Table 4**, the potable water, waste water, and solid waste is consistent across all three environments. Based on the assumptions documented within the ORTB, the water usage is not dependent upon the environment. Even though the waste water production includes the addition of human waste, the waste water produced is less than the water demand due to the assumption that some waste water is suitable for on-site disposal and not collected for backhaul. An example of this is the water used by the vehicle wash rack. Water loss from leaks, spills, and evaporation is not considered within the simulation.

The power and fuel demand results are dependent upon the environment. The temperate environment has a comparatively lower power demand but the largest fuel consumption due to the use of fuel-fired heaters—a direct fuel consumer—in replacement of ECUs during the winter months to maintain the shelter's temperature set point. The switch to fuel-fired heaters is made due to the ECU's inability to maintain the temperature set points in such cold conditions. The Desert environment requires more power than the Tropical, which leads to an increase in fuel utilized for power generation. This breakdown will be further detailed in Section 3.3.1**.**

3.3 FY12 Fuel, Water, and Waste Results

The fuel, water, and waste section provides a detailed breakdown of the basecamp level results for the 300 PAX Ready State use case as documented within the ORTB. The results are discussed for each resource type and further broken down into camp level functions and equipment level functions.

3.3.1 Fuel and Power Demand Results

The fuel and power demand provides a detailed breakdown of the fuel demand results for the 300 PAX Ready State use case as documented within the ORTB. The results are shown in **Table 5** and **Table 6**.

Table 5: Camp Level Functions, Fuel Demand, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	gal/day	Percent Total	gal/day	Percent Total	gal/day	Percent Total
Provide Electric Power	937	90%	882	80%	919	90%
Provide Access to Transportation	59	6%	61	6%	59	6%
Provide Access to Maintenance Repair	18	2%	18	2%	18	2%
Execute Protection	13	1%	13	1%	13	1%
Provide Means to Maintain Personal Hygiene	12	1%	34	3%	10	1%
Provide On Base Lighting	3	0%	3	0%	3	0%
Enable Command and Control	0	0%	1	0%	0	0%
Provide Access to MWR Services	0	0%	4	0%	0	0%
Provide Billeting	0	0%	73	7%	0	0%
Provide Subsistence	0	0%	7	1%	0	0%
Totals	**1042**		**1096**		**1023**	

NOTE: The reader may notice a disparity in the sum totals of some tables. This is due to rounding of values and is of little consequence in the overall results.

Table 6: Equipment Level Functions, Fuel Demand, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	gal/day	Percent Total	gal/day	Percent Total	gal/day	Percent Total
Power Generation	937	90%	882	80%	919	90%
On camp Vehicles	59	6%	61	6%	59	6%
Maintenance	18	2%	18	2%	18	2%
Protection	13	1%	13	1%	13	1%
Water Heating	12	1%	22	2%	10	1%
Lighting	3	0%	3	0%	3	0%
Shelter Heating and Cooling	0	0%	96	9%	0	0%
Totals	1042		1096		1023	

Based upon the results, the *Provide Electric Power* and *Power Generation* functions are the largest consumers of fuel, accounting for 80-90% of the overall fuel depending on the environment. To achieve the SLB-STO-D fuel objective of reducing fuel demand by 25%, this functional area must be addressed. The *Power Generation* functional area can be addressed on both the demand and supply sides by reducing power consumption or by more efficiently producing power.

To assess the possibility of addressing the fuel consumption of the *Power Generation* functional area strictly on the demand side, the fuel consumption of the generators running under no load (i.e. idling) was further investigated. The baseline camp has 23 generators in its layout, which require 671 gal per day (23 generators at 1.215 gal/h over 24 h) just to keep the generators idling under no load. If the power demand were reduced to 0 kWh/day but the generators still had to be used as spinning reserve, the fuel demand would only be reduced by 24%. This shows that any strategy focused on reducing power demand alone will not reach the desired fuel reduction. The challenge is that to achieve the fuel reduction objective of 25%, power must be addressed on the supply side in combination with power consumption reduction. Generators must be available to meet basecamp equipment peak loads, but the generators do not necessarily have to be providing spinning reserve the entire time. Potential options to enable the reduction of fuel usage from power generation include generator right-sizing and/or reallocation of loads and generators, implementing a microgrid, or implementing a hybrid power generation system.

Aside from *Power Generation*, the other functional areas account for a small amount of the overall fuel usage on the basecamp. *Provide Access to Transportation* and *On Camp Vehicles* encompass the largest functional area across all three environments after *Power Generation* with a total percentage of 6%. Approximately half of this functional area is due to transporting fuel, water, and solid waste around the camp. This amount of fuel will be reduced relative to the reduction of these resources.

Lastly, the temperate environment shows a distinct difference compared to the other two environments due to the use of fuel fired heaters in the winter months. This fuel use is spread between several different facilities within the camp level functional breakdown but is combined

within the *Shelter Heating and Cooling* functional area at the equipment level. This accounts for 9% of the overall fuel usage in the temperate environment. Implementing more efficient shelters and ECUs should reduce the fuel usage within this area.

Overall, the fuel demand on the basecamp is dominated by the need for power generation. To further understand the power demands of the basecamp, the power demand will be discussed subsequently.

Table 7: Camp Level Functions, Power Demand, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	kWh/day	Percent Total	kWh/day	Percent Total	kWh/day	Percent Total
Provide Billeting	2402	47%	1422	35%	2203	46%
Provide Subsistence	913	18%	738	18%	895	19%
Enable Command and Control	554	11%	510	12%	556	12%
Provide Means to Maintain Personal Hygiene	428	8%	391	10%	379	8%
Provide Access to MWR Services	302	6%	268	7%	283	6%
Provide Means to Clean Clothes	207	4%	228	6%	207	4%
Provide On Base Lighting	144	3%	144	4%	144	3%
Provide Latrine Services	90	2%	299	7%	77	2%
Provide Access to Maintenance Repair	22	0%	28	1%	19	0%
Provide Access to Medical & Health Services	21	0%	31	1%	18	0%
Execute Protection	14	0%	14	0%	14	0%
Warehouse Store All Supply Classes	13	0%	17	0%	11	0%
Totals	5108		4091		4806	

Table 8: Equipment Level Functions, Power Demand, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	kWh/day	Percent Total	kWh/day	Percent Total	kWh/day	Percent Total
Shelter Heating and Cooling	3045	60%	1927	47%	2728	57%
Lighting	399	8%	399	10%	399	8%
Refrigeration	378	7%	238	6%	395	8%
Convenience Loads	366	7%	366	9%	366	8%
Communications and Computers	344	7%	344	8%	344	7%
Food Prep and Cleaning	282	6%	282	7%	282	6%
Laundry	203	4%	203	5%	203	4%
Water Heating	47	1%	287	7%	44	1%
Water Pumping	27	1%	27	1%	27	1%
Protection	14	0%	14	0%	14	0%
Maintenance	3	0%	3	0%	3	0%
Totals	5108		4091		4806	

The daily average energy demand of the overall basecamp is a small percentage of the available capacity of the generators that are active on the basecamp. Based on the 23 active 60 kW Tactical Quiet Generators (TQG) contained on the camp, the average daily power loading of a generator is between 12-15%, depending on environment. As previously discussed in the fuel section, this leads to potential fuel savings by more efficiently generating power, or more efficiently loading the generators.

The power demand results have less commonality between camp level functions and equipment level functions than the previously shown fuel demand results. For instance, *Provide Billeting* is the largest power demand within the camp level functions at 36%-47% of the overall total basecamp power demand dependent upon environment. Billeting facilities contain components that have several different equipment level functions including *Shelter Heating and Cooling*, *Convenience Loads*, and *Lighting*. In addition, each equipment level function may be contributed to by many different facilities and, therefore, several different camp level functions. For instance, *Shelter Heating and Cooling* is the largest power demand within the equipment level functions at 47%-60% of the overall basecamp power demand dependent upon the environment. *Shelter Heating and Cooling* is contributed to by all climate-controlled facilities including billeting, command and control, latrine, personal hygiene (showers), MWR, medical, maintenance and repair, subsistence, and warehouse facilities. To discuss these results appropriately, camp level functions and equipment level functions will be reviewed separately.

As previously stated, the camp level function within the basecamp with the largest power demand is *Provide Billeting*. Billeting facilities make up 29 of the 78 facilities that demand power (generators and tanks excluded). See the system configuration file located in ANNEX D.

Due to the large percentage of power demand required by billeting, this functional area should be a primary target for reducing the power demand of the overall camp.

Besides the *Provide Billeting* functional area, three other areas account for more than 10% of the overall basecamp power demand in at least one environment. Those three functional areas are: *Provide Subsistence, Enable Command and Control,* and *Provide Means to Maintain Personal Hygiene.* The largest percentage usage of those three is *Provide Subsistence*.

The facilities that contribute to the *Provide Subsistence* functional area are the field kitchens, sanitation systems, dining tents, and the refrigerated containers. These facilities contribute to several major equipment level functions. The kitchens make up 100% of the *Food Prep and Cleaning* equipment level function and refrigerated containers make up most of the *Refrigeration* equipment level function (note: there is a small refrigerator in the medical facility). The last major equipment level function that contributes to the subsistence camp level function is the *Shelter Heating and Cooling* from the dining tents. The overall power required for this camp level function is decreased in the temperate environment during the winter months due to the use of fuel fired heaters in the dining facilities.

The *Enable Command and Control* camp level functional area accounts for 11-12% of the overall power demand. This camp level function is primarily contributed to by two equipment level functions; *Communications and Computers,* and *Shelter Heating and Cooling*. The *Communications and Computers* equipment level function is fully accounted for within the *Command and Control* camp level function. While each component within *Communications and Computers* does not individually account for a large energy demand due to the quantity of these components, the sum-total accounts for a relatively large power demand, which is 7-8% when aggregated. Due to the evolving nature and constant development of more efficient computers, this may be an area in which the Army could look for further power demand reduction, as the SLB-STO-D is not evaluating any potential solutions in this functional area. However, while this seems like a potential area for improvement, as discussed in Section 3.3.1 power demand reduction does not necessarily equate to a significant fuel demand reduction without a more efficient means of power generation. However, with a more efficient means of power generation in place, power reduction may result in an even greater reduction in fuel. Further analysis in this area may be required.

The last camp level function with an overall percentage of 10% or greater is *Provide Means to Maintain Personal Hygiene* in the temperate environment. The other two environments have lower percentages for this functional area due to the lower overall power demand. The desert environment has a larger number of kilowatt-hours associated with this functional area than the temperate environment due to the use of fuel fired heaters in the winter in the temperate environment within the shower facilities, specifically the shower changing tent, thus reducing the direct power demand but increasing the direct fuel demand. The primary equipment level functions that contribute to the camp level function are *Shelter Heating and Cooling* and *Water Heating*. *Water Heating* accounts for a much larger percentage of the power consumption of the camp in the temperate environment due to the low temperature. *Water Heating* also increases the power demand of two other camp level functions in the temperate environment: *Provide Means*

to Clean Clothes and *Provide Latrine Services.* This is primarily due to the heat traces that keep the water from freezing.

Looking at the equipment level functional results, *Shelter Heating and Cooling* accounts for most of the power demand. 47-60% of all power demand on the basecamp is consumed by *Shelter Heating and Cooling*, as it is utilized within almost every facility on the camp. Examining the shelters and ECUs used on the camp shows a wide variety of configurations. **Table 9** and **Table 10** show the number of shelters and ECUs on the 300 PAX basecamp.

Table 9. 300 PAX Basecamp Shelter Breakdown

Shelter Type	Amount
TEMPER 20x32	29
TEMPER 20x21	4
Expandable TRICON	10
LME	4
MILVAN	11
Total	**58**

Table 10. 300 PAX Basecamp ECU Breakdown

ECU	Amount
F-100	33
MTH150	33
Chigo CDS-35H1A	10
Friedrich XQ05M10	4
Space Heater	4
Exhaust Fan	4
Total	**88**

Based upon these breakdowns and the fact that the F-100 has a larger power consumption than the other ECUs, the most obvious components to target to get the largest power demand reduction would be the TEMPER shelters, the MTH150 fuel fired heaters, and the F-100 ECUs. These three components are used together within several facilities such as billeting tents, dining tents, and shower changing tents. All the other shelters and ECUs should be considered for power demand reduction only after addressing those facilities.

The *Lighting* equipment level function is the second highest power demand at 8-10%. The *Lighting* power demand is largely contributed to by two components: the Jameson lights used in many facilities, including billeting, and the perimeter flood lights. The Jameson lights do not draw a significant amount of power, but there are 308 of them across the basecamp used in various facilities for different time periods of the day, so the sum power demand is relatively large. The other contributing component is the perimeter flood lights. Each set of perimeter flood lights draw 4.5 kW when on. Replacing either of these components with more efficient versions would result in a significant reduction in power demand.

Refrigeration, Communications and Computers, Food Prep and Cleaning, and *Water Heating* have been discussed previously within the context of the camp level functions. The only other

equipment level function that accounts for greater than 5% of the overall power demand is *Convenience Loads.* Convenience (outlets) loads are largely driven by the soldiers on the basecamp and reducing this demand would require the enforcement of human behavior change that would reduce the QoL (O) on the basecamp.

3.3.2 Water Demand Results

The water demand section provides details of the water results for the 300 PAX Ready State use case as documented within the ORTB. The results are shown in **Table 11** and **Table 12.**

Table 11: Camp Level Functions, Water Demand, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	gal/day	Percent Total	gal/day	Percent Total	gal/day	Percent Total
Provide Means to Maintain Personal Hygiene	4961	57%	4961	57%	4961	57%
Provide Latrine Services	2321	27%	2321	27%	2321	27%
Provide Means to Clean Clothes	751	9%	751	9%	751	9%
Provide Subsistence	370	4%	370	4%	370	4%
Provide Access to Maintenance Repair	312	4%	312	4%	312	4%
Provide Access to Medical & Health Services	8	0%	8	0%	8	0%
Totals	8723		8723		8723	

Table 12: Equipment Level Functions, Water Demand, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	gal/day	Percent Total	gal/day	Percent Total	gal/day	Percent Total
Hygiene and Showers	5468	63%	5468	63%	5468	63%
Latrine	1822	21%	1822	21%	1822	21%
Laundry	751	9%	751	9%	751	9%
Food Prep and Cleaning	370	4%	370	4%	370	4%
Maintenance	312	4%	312	4%	312	4%
Totals	8723		8723		8723	

NOTE: The reader may notice that in some tables the percentages of demand do not total 100%. This is due to rounding of values and is of little consequence in the overall results.

The water demand results of the basecamp are different from both the fuel and power demand results previously discussed in that there is no variance between the environments. This is to be

expected, since the assumptions made within the ORTB do not identify any variance in water usage based upon environmental differences.

The water demand totals show a large dependency upon the amount of water utilized to *Provide Means to Maintain Personal Hygiene*. This camp level functional area accounts for the shower facilities, which is the largest water consuming facility. Within the equipment level function, *Hygiene and Showers*, the latrine sink usage is added from the latrine facilities. Latrine sink use accounts for almost 500 gal of water use per day.

The camp level function with the second largest overall percentage use of water on the basecamp is *Provide Latrine Services*. The latrine facilities account for 27% of the overall water usage on the basecamp. Both the shower and latrine facilities must be addressed to meet the SLB-STO-D water demand reduction objective of 75%, since each account for greater than 25% of the overall usage. These two facilities should be primary targets for water reduction. One potential solution includes reducing the water required without compromising the basecamp capabilities. Options for consideration include waterless urinals, low flow shower heads and toilets, etc. or reusing/recycling graywater from the basecamp.

Another functional area that accounts for a large percentage of the overall water demand is the *Laundry* equipment level function which utilizes 9% of the water on the basecamp. The laundry and shower facilities output graywater that could be recycled and potentially reused in certain applications. Since facilities that generate graywater account for 66% of the overall water usage on the basecamp, these should be a target for water reduction. For further information regarding graywater, please see Section 3.3.3.1.

Water reduction has the added benefit of reducing the wastewater generation on the basecamp, as well. Several of the targets for water reduction will carry over to the wastewater generation in Section 3.3.3.1. In addition, reducing water usage on the camp has a second order effect of re-filling/emptying blivets and tanks less frequently, which leads to a reduction in fuel usage for on-camp vehicles. See Section 3.3.1 for further fuel results.

3.3.3 Waste Generation Results

The waste generation section provides a detailed breakdown of the waste generation results for the 300 PAX Ready State use case as documented within the ORTB. Waste generation is broken down into two categories: wastewater and solid waste.

3.3.3.1 Wastewater Generation Results

The wastewater generation section provides a detailed breakdown of the wastewater generation results for the 300 PAX Ready State use case as documented within the ORTB. The results are shown in Table 13 and Table 14.

Table 13: Camp Level Functions, Wastewater Generation, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	gal/day	Percent Total	gal/day	Percent Total	gal/day	Percent Total
Provide Means to Maintain Personal Hygiene	4961	58%	4961	58%	4961	58%
Provide Latrine Services	2447	29%	2447	29%	2447	29%
Provide Means to Clean Clothes	751	9%	751	9%	751	9%
Provide Subsistence	370	4%	370	4%	370	4%
Totals	8529		8529		8529	

Table 14: Equipment Level Functions, Wastewater Generation, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	gal/day	Percent Total	gal/day	Percent Total	gal/day	Percent Total
Hygiene and Showers	5460	64%	5460	64%	5460	64%
Latrine	1948	23%	1948	23%	1948	23%
Laundry	751	9%	751	9%	751	9%
Food Prep and Cleaning	370	4%	370	4%	370	4%
Totals	8529		8529		8529	

The wastewater generation results appear to be very similar to the water demand results. Often the components that require water as an input produce a wastewater by-product as an output. There are two key differences between the water demand and the wastewater generation results. The first is that the *Maintenance* functional area is not seen in the wastewater generation since the wash rack's water is assumed to be disposed of onsite and is therefore not collected. Also, the quantity of wastewater generated by the *Latrine* equipment level function is larger than the water demand due to the addition of human waste within the waste water.

The wastewater by-products are designated separately as graywater or blackwater. Blackwater is source-separated wastewater from latrines and kitchens containing one or more of the following: urine, feces, toilet paper, food waste, and flush water [5]. This includes the latrine sink usage due to the combining of liquids in the wastewater tank attached to the latrine. Graywater is generated primarily by the showers and laundry facilities.

Most of the wastewater generation on a camp is graywater from the shower facilities and laundry facilities, which account for 58% and 9% respectively. Blackwater, from the latrine and kitchen facilities, account for 33% of all wastewater.

There are three primary ways to reduce wastewater on a basecamp. Reducing the overall water demand of the basecamp will also reduce the wastewater generated on the basecamp. See Section

3.3.3 for more details. In addition, reusing or recycling the wastewater can greatly reduce the need for wastewater backhaul. This also has the added benefit of also reducing the potable water demand of the camp. An example of this would be graywater recycling. Lastly, treating the wastewater to enable onsite disposal rather than backhaul greatly reduces the overall wastewater metric. This can be accomplished with an expeditionary wastewater treatment system.

For the SLB-STO-D to meet its wastewater reduction objective, the shower facility must be addressed, as it accounts for 58% of all wastewater generation. There are several options to be considered including water demand reduction (i.e. low flow shower heads), graywater recycling, or some combination thereof. In addition, the latrine facility usage of 29% of all wastewater generation will likely have to be addressed as well. Options for wastewater reduction within the *Latrine* functional area include source reduction (i.e. low flow toilets or waterless urinals), proper water classification (latrine sinks), or blackwater treatment for onsite disposal.

Many of the potential solutions for wastewater reduction or recycling would require additional fuel and/or power consumption. Future analysis will be completed to account for this trade-off.

3.3.3.2 Solid Waste Generation Results

The solid waste generation section provides a breakdown of the solid waste generation results for the 300 PAX Ready State use case as documented within the ORTB. The results are shown in **Table 15** and **Table 16.**

Table 15: Camp Level Functions, Solid Waste Generation, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	lb/day	Percent Total	lbs./day	Percent Total	lb/day	Percent Total
Provide Solid Waste Management	2870	100%	2870	100%	2870	100%
Totals	2870		2870		2870	

Table 16: Equipment Level Functions, Solid Waste Generation, 300 PAX, Ready State

Functional Areas	Desert		Temperate		Tropical	
	lb/day	Percent Total	lb/day	Percent Total	lb/day	Percent Total
Solid Waste Generation	2870	100%	2870	100%	2870	100%
Totals	2870		2870		2870	

Solid waste on the 300 PAX basecamp is designated as 9.2 lb per person per day (see the ORTB for further details on the breakdown and assumptions for solid waste generation on a basecamp). While the simulation does not go into detail regarding the sources of solid waste, the ORTB specifies that 54% of the solid waste generated on the basecamp comes from field feeding. To address solid waste on the generation side, the waste from field feeding will likely have to be reduced.

Similar to the wastewater resource, the solid waste can be reduced through two methods: reducing the sources of solid waste generation, or reducing the need for back-haul by utilizing methods of onsite disposal. STO-D will explore both options to meet the solid waste reduction metric of 50%.

3.4 QoL (O)

In previous sections, the report has focused on the fuel, power, and water usage along with wastewater and solid waste generation of the SLB-STO-D baseline basecamps. The QoL(O) section discusses the impact of QoL(O) on soldiers living in basecamps. It briefly describes the quantitative method used and basecamp baseline results for the three camp variations. These results will be used by the SLB-STO-D to quantitatively assess the QoL(O) impacts of inserting various potential solutions into these baseline camps. A full explanation of the background and methods for quantifying QoL(O) at basecamps can be found in the "Soldier Quality of Life: Final Report" [6].

QoL(O) is important to the basecamp problem space. Basecamps are the force projection platform to sustain and restore Soldier readiness during a deployment. The goal is to understand the impacts of Soldier and small unit basecamp operational QoL as an enabler of Soldier and small unit readiness in the expeditionary and complex fight. The performance triad (**Figure 4**), a comprehensive U.S. Army initiative, identifies sleep, physical activity, and nutrition as all being critical to optimize Soldier readiness. Specific assets available on a basecamp will influence the quality of all three of these domains. For example, billets can contribute to sleep quality, field feeding drives nutrition and hygiene, and MWR services drive activities that restore readiness [7].

The challenge is to find the right balance between basecamp efficiency and QoL (O). However, there was no way to quantify or predict QoL (O) on basecamps to inform trade-offs between QoL (O) and basecamp efficiency. In order to quantify QoL (O) on basecamps. The SLB-STO-D, with the aid of the NSRDEC Consumer Research team (CRT), developed a tool that could provide the assessment.

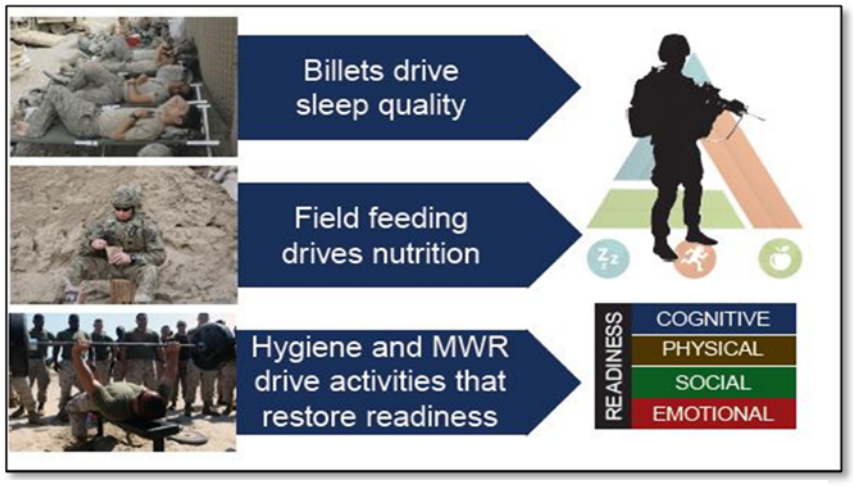

Figure 4: Performance Triad

The CRT did preliminary qualitative research, pilot testing, and analysis from the period of October 2013 to November 2014, which led to the development of a QoL survey instrument. The CRT used the QoL instrument to survey approximately 1,200 Soldiers, on which they

received feedback on critical aspects of QoL(O) at contingency basecamps. The data was collected from July through September 2014 at the following locations: Ft. Polk, Ft. Stewart, Ft. Riley, Joint Base Lewis-McChord, and Camp Edwards. [6].

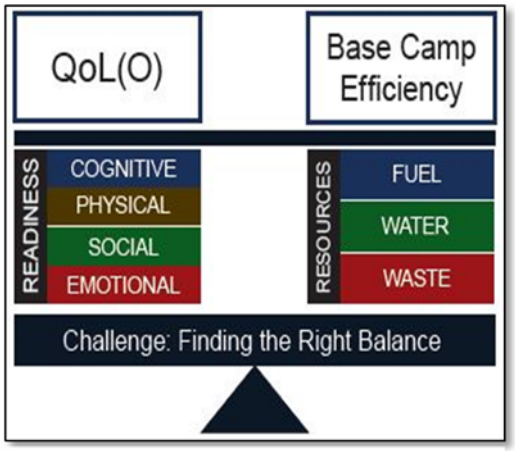

Figure 5: QoL(O) vs. Basecamp Efficiency

The goal of quantifying QoL(O) is to provide science and technology decision makers the information to balance resources (**Figure 5**) with other factors that lead to effective basecamps. While this QoL assessment does not evaluate the impact on Soldier readiness, it does focus on the QoL attributes that intuitively have a potential impact on Soldier readiness. A follow-on study is underway which takes the lessons learned from this QoL(O) work and seeks to determine which factors relate most to Soldier readiness.

QoL (O) Scores

A QoL(O) tool was created to allow the SLB-STO-D to utilize the collected Soldier survey data. This tool enables mapping of various basecamp configurations to their QoL(O) attribute levels. The output of this tool is not only a score between 0 and 100, but includes the individual scores by functional area (**Table 17**) as well as the individual mappings of the 84 attributes. The intent of the tool is not to try and establish a "good" or "bad" QoL(O) score—it is simply a comparison tool for comparing one camp to another. Considering the functional area scores can further help a basecamp designer understand the QoL(O) impact of various services on a camp. As described in the QoL report [6], the relative impact of each attribute and attribute level is considered; therefore, some attribute levels will change the functional or overall score more than others.

Table 17: QoL scores by Functional Areas

Camp	Field Feeding	Hygiene	Billets	MWR	Spiritual/ Psych Support	Personal Security	Work Area
50 PAX Baseline	7.1	0.5	9.5	7.8	0	0	6.3
300 PAX Baseline	12.0	14.1	9.5	20.6	0.3	2.4	6.4
1000 PAX Baseline	13.0	14.3	9.5	21.3	0.7	2.4	6.3

As expected, the QoL(O) scores for the 300 and 1000 PAX camps are similar, while the 50 PAX camp is considerably lower (**Table 18**). The slight differences on the 300 and 1000 PAX camps are due to ice availability, a dedicated sacred space (i.e., religious worship), more access to cardio equipment, and different laundry services on the 1000 PAX camp.

Table 18: QoL (O) Camp Scores

Camp	QoL(O) Camp Score
50 PAX Baseline	31.3
300 PAX Baseline	65.3
1000 PAX Baseline	67.4

The lower QoL(O) scores on the 50 PAX camp are due to many factors. The lack of shower and laundry facilities as well as the burn-out latrines account for most of the differences in the hygiene area. A field feeding plan of two MREs per day as well as UGR-Es vs. UGR-As and the lack of fresh fruits and vegetables account for the lower field feeding score. The lack of dedicated MWR space and equipment within those structures as well as the reduced frequency of mail and package delivery accounts for the lower score in the MWR area. This 50 PAX camp is very austere and the use case scenario defines a 7-day resupply frequency as well as a 21-day rotation schedule. It is assumed that Soldiers on this camp would go without some services for 21 days, then rotate up to a larger camp where more services are available. See [1] for more details.

Of note, the ORTB includes an alternative use case where the population on the camp surges by 30%. The camps are sized to handle this surge and the impacts are low enough that they don't change the QoL assessment of the camp. Because the QoL(O) attribute levels are discrete, this use case does not change them to the next level, so the scores seen in **Table 18** are the same for the ready state and the population surge.

Figure 6 is a partial screenshot of the QoL tool used in this analysis.

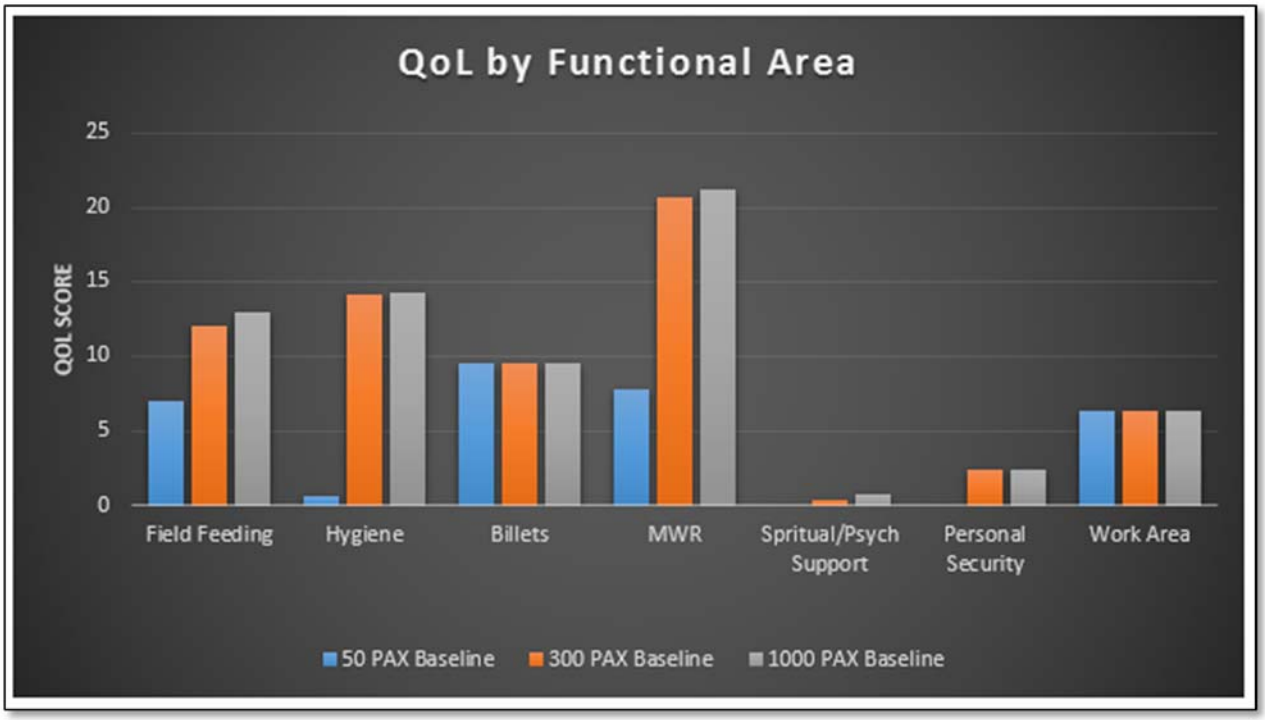

Figure 6: Partial screenshot of QoL tool

4. CONCLUSIONS AND INSIGHTS

All fuel and water demand, waste generation and backhaul, and QoL (O) results for the FY12 ORTB 50, 300, and 1000 PAX Ready State and Population variance use cases have been presented. The SLB-STO-D analysis purpose, approach, and methodology have been presented for the reader to garner a better understanding of the complexity of the modeling and analysis. These baseline results enable comparison of future analysis to show how non-materiel and materiel solutions impact the fuel, water, and waste resources on a basecamp. Lastly, many of the top contributors and insights gained from this baseline analysis have been presented and discussed in previous sections of this report.

Some of the key insights presented are summarized below:

- The vast majority (80-90%) of fuel usage on basecamps is due to power generation.
- Power reduction does not have a one-to-one reduction with fuel due to the generator's fuel consumption in an idle state. Power generation on the supply side must be addressed along with reducing power demand to achieve the SLB-STO-D objective of 25% fuel reduction.
- The majority (47-60%) of power consumption on the basecamp is due to shelter heating and cooling. This should be the primary target for power reduction.
- Two facilities have larger than 25% contributions to the water usage on the basecamp: showers and latrines. Both facilities must have decreased water demand or net usage reduction for the SLB-STO-D objective of 75% water demand reduction to be achieved.
- The primary wastewater contributors are the same facilities, shower and latrines, as the water demand contributors. Both solid and liquid waste can be addressed through reduction on the demand side, recycling, or treatment for on-site disposal. All three options should be explored to achieve the SLB-STO-D objective of 50% waste reduction.

5. RECOMMENDATION

Several key functional areas of the basecamp have been identified in this report as having the largest impact on fuel, water, and waste.

It is recommended that in future work, the SLB-STO-D build upon these insights and assess the impact of the integration of various materiel and non-materiel solutions into the ORTB basecamps against these same metrics.

Furthermore, while fuel and water consumption, waste generation, and QoL(O) are key metrics in the design and sustainment of a basecamp, several other attributes contribute to the success of basecamps. These attributes include reliability, availability, maintainability, cost, manpower, complexity, footprint, and many others. An opportunity exists to establish a baseline of these attributes for the ORTB basecamps, which would allow for the analysis of materiel and non-material solutions across these dimensions. Establishing such a baseline is not currently within the scope of the SLB-STO-D program; however, the SLB-STO-D will provide insights into these attributes and discuss tradeoffs for the technologies included in the materiel solution sets designed to meet the objective fuel, water, and waste savings.

This document reports research undertaken at the U.S. Army Natick Soldier Research, Development and Engineering Center, Natick, MA, and has been assigned No. NATICK/TR- 17/011 in a series of reports approved for publication.

6. REFERENCES

[1] *Technology Enabled Capability Demonstration (TECD) 4a*. (August 3, 2016). *Technology Enabled Capability Demonstration (TECD) 4a: Sustainability/Logistics – Basing Operationally Relevant Technical Baseline 50 Tenant Base Camp, FY 2012 Equipment, Systems and Standards, Version 1.2*

[2] *Technology Enabled Capability Demonstration (TECD) 4a.*. (August 3, 2016). *Technology Enabled Capability Demonstration (TECD) 4a: Sustainability/Logistics – Basing Operationally Relevant Technical Baseline 300 Personnel Base Camp, FY 2012 Equipment, Systems and Standards, Version 1.2*

[3] *Technology Enabled Capability Demonstration (TECD) 4a.*. (August 3, 2016). *Technology Enabled Capability Demonstration (TECD) 4a: Sustainability/Logistics – Basing Operationally Relevant Technical Baseline 1000 Personnel Base Camp, FY 2012 Equipment, Systems and Standards, Version 1.2*

[4] *Technology Enabled Capability Demonstration (TECD) 4a.*. (Date: December 18, 2015). *Analysis Architecture for Operationally Relevant Technical Baseline (ORTB) 50, 300, 1000 Personnel Base Camps*

[5] U.S. Army Public Health Command. (2014). *Water Reuse in Contingency Operations: A Strategy for Comprehensive Health Risk Management*

[6] Federici, J. et al. (September 2016) *Operational Quality of Life Assessment: Final Report*

[7] *Performance Triad*. (Date of publication: unknown) Retrieved from URL http://armymedicine.mil/Pages/performance-triad.aspx

LIST OF ACRONYMS

AMSAA	Army Materiel Systems Analysis Activity
CERL	Construction Engineering Research Laboratory
COP	combat outpost
DCAM	Detailed Component Analysis Model
DTIC	Defense Technical Information Center
ECU	Environmental Control Unit
ERDC	Engineer Research and Development Center
FY	fiscal year
LME	Lightweight Maintenance Enclosure
MATLAB	Matrix Laboratory (Mathworks, Inc._
MBSE	model-based systems engineering
MILVAN	military shipping container
MRE	Meal, Ready to Eat
MSCoE	Maneuver Support Center of Excellence
MWR	morale, welfare, and recreation
NSRDEC	Natick Soldier Research, Development and Engineering Center
ORTB	Operationally Relevant Technical Baseline
OV	operation view
PAX	passenger (per JP 1-2; however, for the purposes of the report, PAX is used synonymously with “persons” or “personnel.”)
PB	patrol base
PdD-CBI	Product Director-Contingency Basins Infrastructure
PdM-FSS	Product Manager-Force Sustainment Systems
QoL	quality of life
QoL(O)	operational quality of life
RDEC	Research, Development and Engineering Center
RDECOM	Research, Development and Engineering Command
S&T	science and technology
SCoE	Sustainment Center of Excellence
SLB-STO-D	Sustainability/Logistics-Basing Science and Technology Objective – Demonstration
SME	subject matter expert
TECD	Technology-enable Capability Demonstration
TEMPER	Tent, Expandable, Modular, Personnel
TQG	Tactical Quiet Generator
TRICON	triple container
UGR-A	Unitized Group Ration – A Option
UGR-E	Unitized Group Ration – Express
VFOB	Virtual Forward Operating Base

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ANNEX A – FY12 ORTB Equipment List, By Basecamp Size

Table A-1: Equipment List, By Basecamp Size

	Quantity		
	50 PAX	300 PAX	1000 PAX
	Provide Electric Power		
30 kW Tactical Quiet Generator (TQG)	6	-	-
30 kW Tactical Quiet Generator (TQG) (Spares, Off)	1	-	-
60 kW Tactical Quiet Generator (TQG)	-	23	73
60 kW Tactical Quiet Generator (TQG) (Spares, Off)	-	3	8
	Enable Command and Control		
A/S TEMPER 20x32 (Single-Ply Liner, F100 ECU, MTH150)	-	1	1
B-Hut Shelter (F100 ECU, MTH150)	1	-	2
MILVAN Shelter (COTS ECU)	-	2	9
Meteorological Measuring Set, AN-TMQ-52	-	-	1
Network Communications Hub (F100 ECU)	-	-	1
Satellite Transportable Terminal, AN-TSC-185	-	1	-
	Enable Communications		
MILVAN Shelter (COTS ECU)	-	-	1
A/S TEMPER 20x32 (Single-Ply Liner, F100 ECU, MTH150)	-	-	2
Entry Control Point, Unpowered	2	-	-
Entry Control Point with Electric Gate	-	2	2
Guard Tower	-	-	16
Radar Cluster	1	1	2
Radar Set, AN-TPQ-36-V-8	-	-	1
	Provide Access to Maintenance/Repair		
Large Area Maintenance Shelter (LAMS) (2 Large Capacity Field Heaters (LCFH))	-	-	1
Lightweight Maintenance Enclosure (LME) (No ECU)	1	1	4
M7 Forward Repair System	-	1	-
MILVAN Shelter (COTS ECU)	-	1	2
Wash Rack	-	1	2
	Provide Access to Medical & Health Services		
MILVAN Shelter (COTS ECU)	1	1	2
	Provide Access to MWR Services		
A/S TEMPER 20x32 (Single-Ply Liner, F100 ECU, MTH150)	-	-	4
Lightweight Maintenance Enclosure (LME) (F100 ECU, MTH150)	-	1	-
MILVAN Shelter (COTS ECU)	-	1	2

Table A-1: Equipment List, By Basecamp Size (Continued)

	Quantity		
	50 PAX	300 PAX	1000 PAX
	Provide Access to Transportation		
Vehicle Support Set	1	1	1
A/S TEMPER 20x32 (Single-Ply Liner, F100 ECU, MTH150)	6	23	72
A/S TEMPER 20x32 (Unoccupied, Off)	-	2	4
Containerized Housing Unit (COTS ECU)	-	-	3
Containerized Housing Unit (Unoccupied, Off)	-	-	2
MILVAN Shelter (COTS ECU)	-	-	4
MILVAN Shelter (Unoccupied, Off)	1	4	4
	Provide Latrine Services		
Burn Out Latrine	4	-	-
Expeditionary Latrine System (ELS)	-	4	20
	Provide Means to Clean Clothes		
B-Hut Shelter (F100 ECU, MTH150)	-	-	1
Expeditionary Containerized Batch Laundry (ECBL) System	-	-	4
Hand Wash Bucket	1	-	-
MILVAN Shelter (COTS ECU) with COTS Washer and Dryer	-	1	-
	Provide Means to Maintain Personal Hygiene		
A/S TEMPER 20x21 (Single-Ply Liner, F100 ECU, MTH150)	-	4	20
Expeditionary Shower System (ESS)	-	4	20
Hand Wash Station	3	-	-
	Provide On Base Lighting		
Fuel-Powered Light Set	-	1	1
Perimeter Lights	6	24	70
	Provide Subsistence		
A/S TEMPER 20x32 (Single-Ply Liner, F100 ECU, MTH150)	1	2	4
Containerized Kitchen System	-	-	2
Expeditionary TRICON Kitchen System (ETKS)	-	2	-
Food Sanitation Center	-	-	2
Multi-Temperature Refrigerated Container System (MTRCS)	-	3	7
TRICON Refrigerated Container System (TRCS)	-	2	-
	Warehouse/Store All Supply Classes		
A/S TEMPER 20x32 (Single-Ply Liner, F100 ECU, MTH150)	-	-	1
Lightweight Maintenance Enclosure (LME) (No ECU)	-	3	6
MILVAN Shelter (COTS ECU)	-	1	-

ANNEX B – FY12 ORTB Base Camp Layout, By Base Camp Size

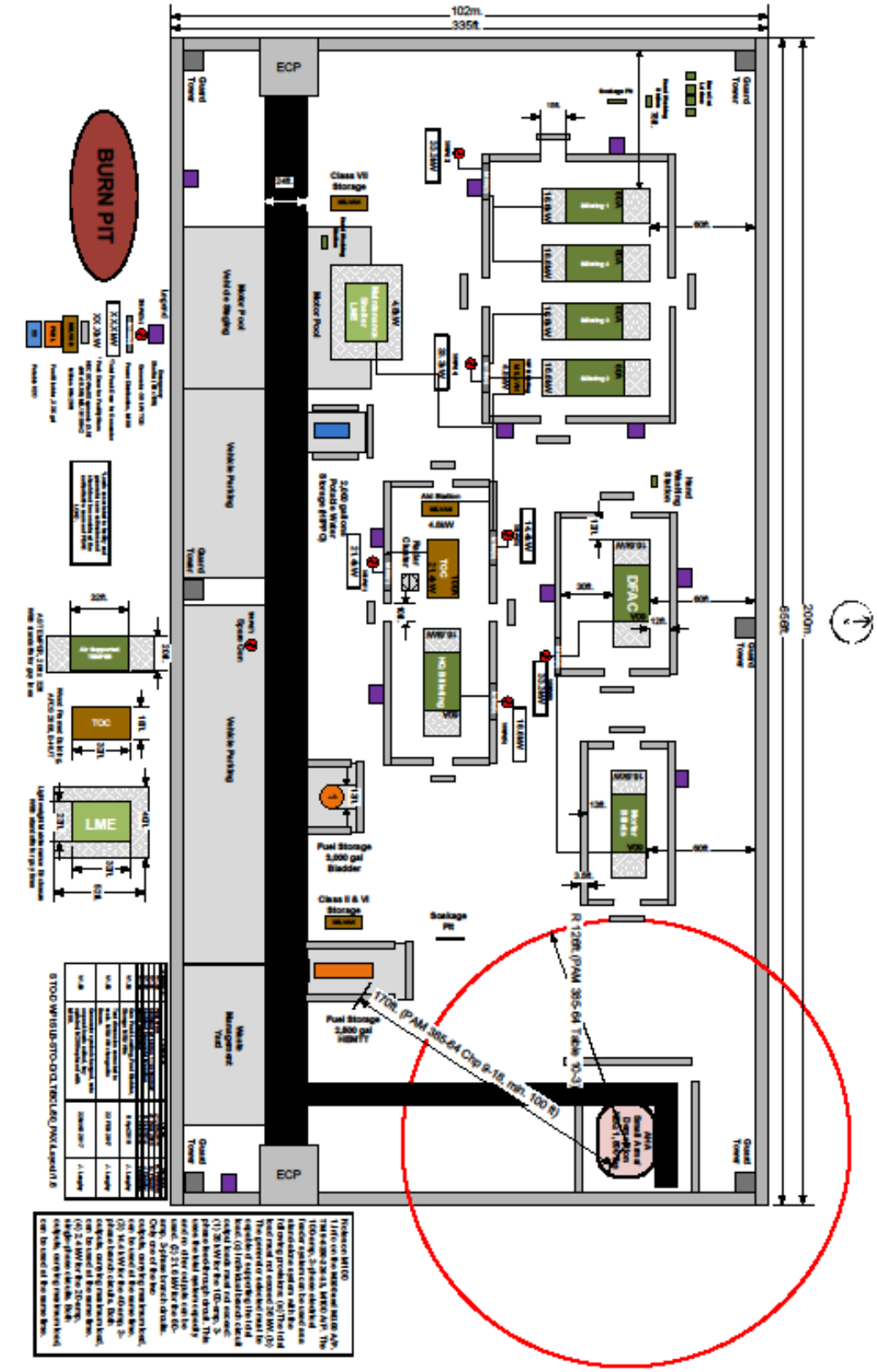

Figure B-1: Base Camp Layout, 50PAX

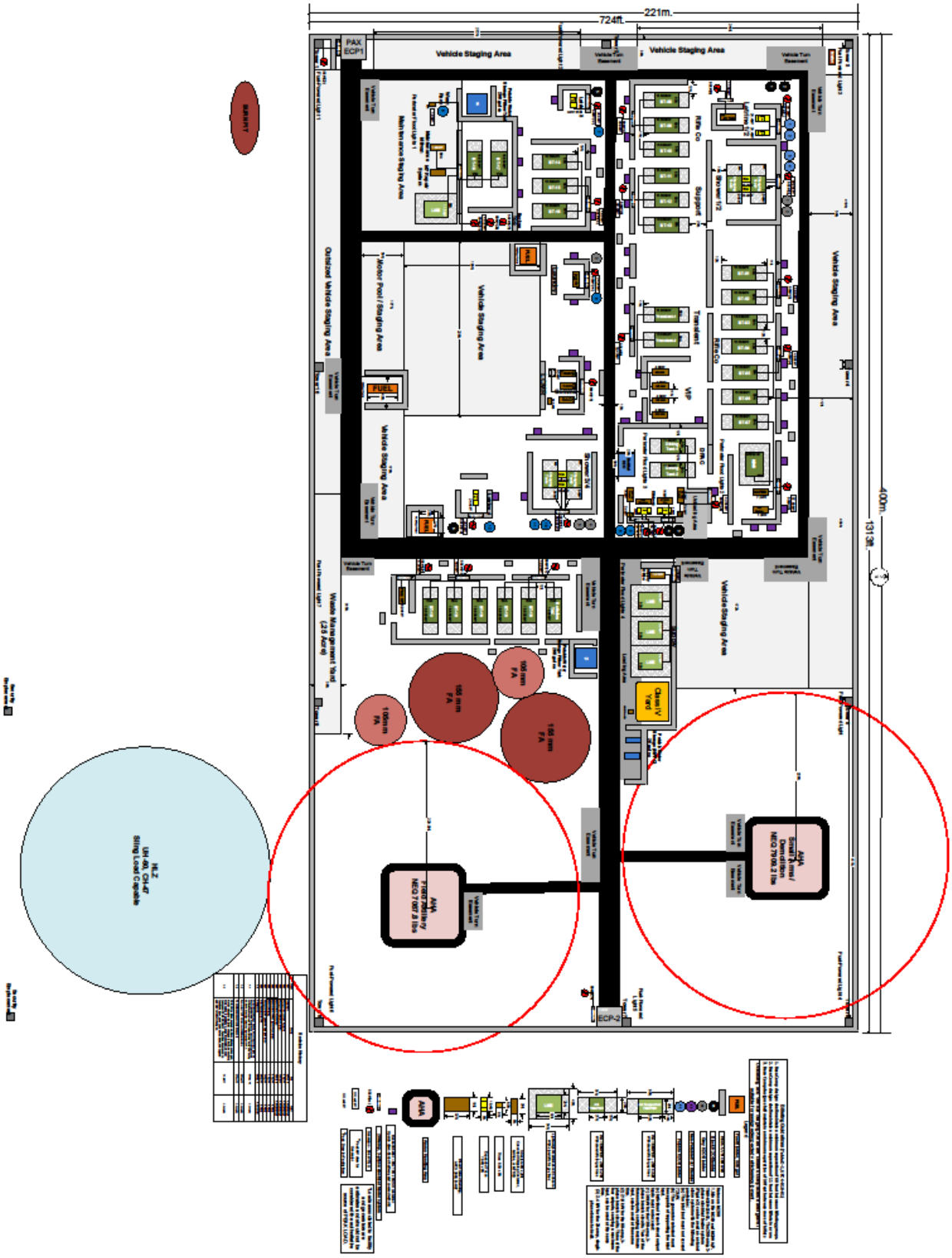

Figure B-2: Base Camp Layout, 300PAX

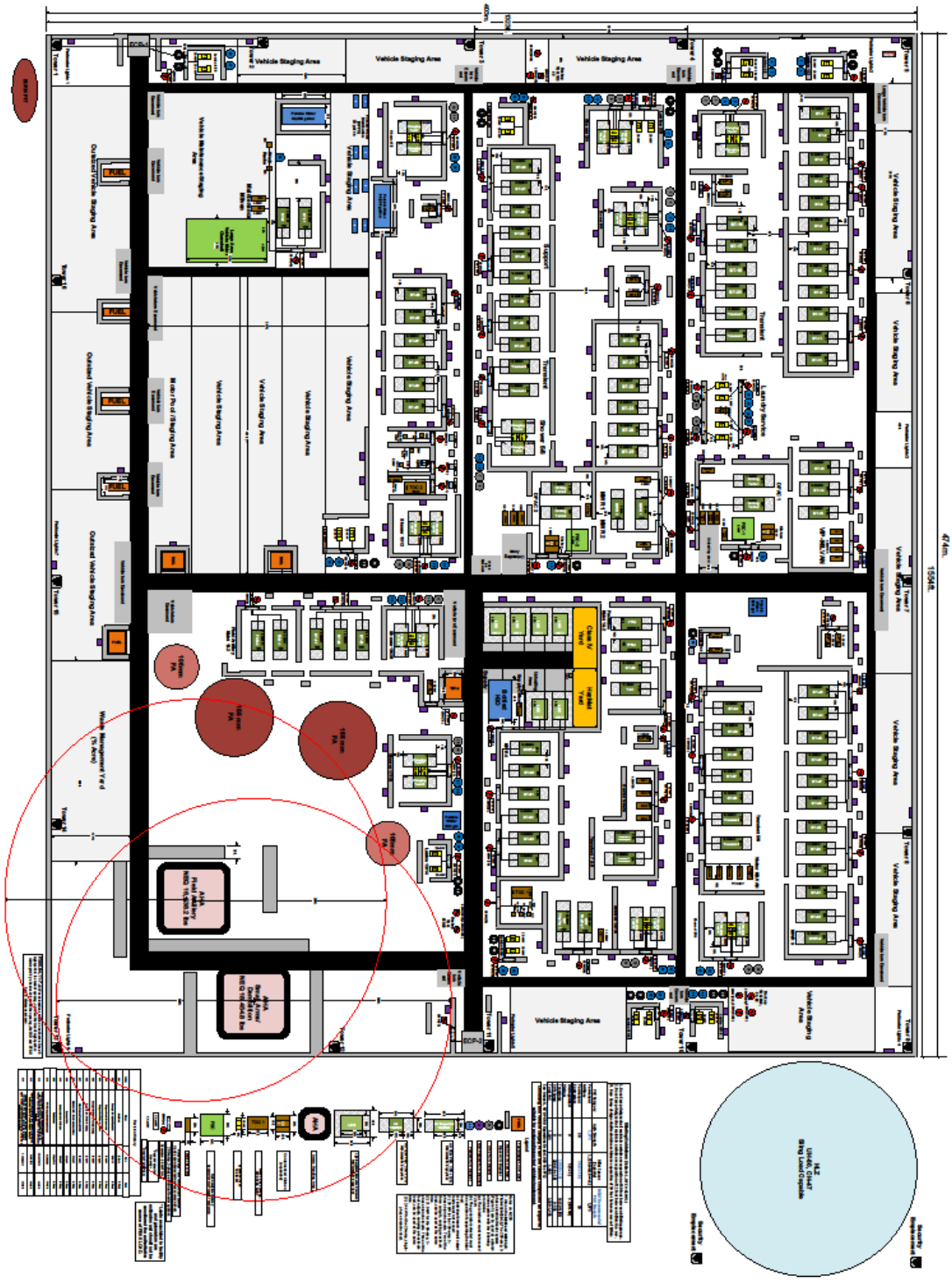

Figure B-3: Base Camp Layout, 1000PAX

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ANNEX C – FY12 ORTB Results, By Basecamp Size

C.1 50 PAX Results

C.1.1 Ready State Results

Table C-1: Camp Level Summary, 50 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Power Demand (Mean kWh/day)	1007	661	951
Fuel Demand (Mean gal/day)	215	219	212
Potable Water Demand (Mean gal/day)	75	75	75
Waste Water Generation (Mean gal/day)	27	27	27
Solid Waste Generation (Mean lbs./day)	266	266	266

C.1.2 Fuel Demand Results

Table C-2: Camp Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Electric Power	177	158	174
Provide Latrine Services	20	20	20
Execute Protection	13	13	13
Provide Access to Transportation	5	5	5
Enable Command and Control	0	1	0
Provide Billeting	0	19	0
Provide Subsistence	0	4	0
Totals	**215**	**219**	**212**

Table C-3: Equipment Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Power Generation	177	158	174
Latrine	20	20	20
Protection	13	13	13
On camp Vehicles	5	5	5
Shelter Heating and Cooling	0	23	0
Totals	**215**	**219**	**212**

C.1.3 Power Demand Results

Table C-4: Camp Level Functions, Power Demand (Mean kWh/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Billeting	624	368	572
Enable Command and Control	231	170	247
Provide Subsistence	118	79	100
Provide Access to Medical & Health Services	21	31	18
Execute Protection	8	8	8
Provide Access to Maintenance Repair	5	5	5
Totals	**1007**	**661**	**951**

Table C-5: Equipment Level Functions, Power Demand (Mean kWh/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Shelter Heating and Cooling	788	443	732
Comms and Computers	92	92	92
Lighting	63	63	63
Convenience Loads	47	47	47
Protection	17	17	17
Refrigeration	0	0	0
Totals	**1007**	**661**	**951**

C.1.4 Water Demand Results

Table C-6: Camp Level Functions, Water Demand (Mean gal/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Means to Clean Clothes	46	46	46
Provide Means to Maintain Personal Hygiene	27	27	27
Provide Access to Medical & Health Services	2	2	2
Totals	**75**	**75**	**75**

Table C-7: Equipment Level Functions, Water Demand (Mean gal/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Laundry	46	46	46
Hygiene and Showers	29	29	29
Totals	**75**	**75**	**75**

C.1.5 Waste Generation Results

C.1.5.1 Waste Water Generation Results

Table C-8: Camp Level Functions, Waste Water Generation (Mean gal/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Means to Maintain Personal Hygiene	27	27	27
Totals	**27**	**27**	**27**

Table C-9: Equipment Level Functions, Waste Water Generation (Mean gal/day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Hygiene and Showers	27	27	27
Totals	**27**	**27**	**27**

C.1.5.2 Solid Waste Generation Results

Table C-10: Camp Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Solid Waste Management	266	266	266
Totals	**266**	**266**	**266**

Table C-11: Equipment Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Solid Waste Generation	266	266	266
Totals	**266**	**266**	**266**

C.1.6 Population Variance Results

C.1.6.1 Camp Level Summary Results

Table C-12: Camp Level Summary, 50 PAX, Population Variance, Desert

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	1007	1007	0%
Fuel Demand (Mean gal/day)	215	215	0%
Potable Water Demand (Mean gal/day)	75	99	31%
Waste Water Generation (Mean gal/day)	27	35	31%
Solid Waste Generation (Mean lbs./day)	266	349	31%

Table C-13: Camp Level Summary, 50 PAX, Population Variance, Temperate

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	661	661	0%
Fuel Demand (Mean gal/day)	219	219	0%
Potable Water Demand (Mean gal/day)	75	99	31%
Waste Water Generation (Mean gal/day)	27	35	31%
Solid Waste Generation (Mean lbs./day)	266	349	31%

Table C-14: Camp Level Summary, 50 PAX, Population Variance, Tropical

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	951	951	0%
Fuel Demand (Mean gal/day)	212	212	0%
Potable Water Demand (Mean gal/day)	75	99	31%
Waste Water Generation (Mean gal/day)	27	35	31%
Solid Waste Generation (Mean lbs./day)	266	349	31%

C.1.6.2 Fuel Demand Results

Table C-15: Camp Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	177	177	0.00%
Provide Latrine Services	20	20	0.00%
Execute Protection	13	13	0.00%
Provide Access to Transportation	5	5	0.00%
Enable Command and Control	0	0	N/A
Provide Billeting	0	0	N/A
Provide Subsistence	0	0	N/A
Totals	**215**	**215**	**0%**

Table C-16: Camp Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	158	158	0.00%
Provide Latrine Services	20	20	0.00%
Execute Protection	13	13	0.00%
Provide Access to Transportation	5	5	0.00%
Enable Command and Control	1	1	0.00%
Provide Billeting	19	19	0.00%
Provide Subsistence	4	4	0.00%
Totals	**219**	**219**	**0%**

Table C-17: Camp Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	174	174	0.00%
Provide Latrine Services	20	20	0.00%
Execute Protection	13	13	0.00%
Provide Access to Transportation	5	5	0.00%
Enable Command and Control	0	0	N/A
Provide Billeting	0	0	N/A
Provide Subsistence	0	0	N/A
Totals	**212**	**212**	**0%**

Table C-18: Equipment Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	177	177	0.00%
Latrine	20	20	0.00%
Protection	13	13	0.00%
On camp Vehicles	5	5	0.00%
Shelter Heating and Cooling	0	0	N/A
Totals	**215**	**215**	**0%**

Table C-19: Equipment Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	158	158	0.00%
Latrine	20	20	0.00%
Protection	13	13	0.00%
On camp Vehicles	5	5	0.00%
Shelter Heating and Cooling	23	23	0.00%
Totals	**219**	**219**	**0%**

Table C-20: Equipment Level Functions, Fuel Demand (Mean gal/day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	174	174	0.00%
Latrine	20	20	0.00%
Protection	13	13	0.00%
On camp Vehicles	5	5	0.00%
Shelter Heating and Cooling	0	0	N/A
Totals	**212**	**212**	**0%**

C.1.6.3 Power Demand Results

Table C-21: Camp Level Functions, Power Demand (Mean kWh/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	624	624	0.00%
Enable Command and Control	231	231	0.00%
Provide Subsistence	118	118	0.00%
Provide Access to Medical & Health Services	21	21	0.00%
Execute Protection	8	8	0.00%
Provide Access to Maintenance Repair	5	5	0.00%
Totals	**1007**	**1007**	**0%**

Table C-22: Camp Level Functions, Power Demand (Mean kWh/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	368	368	0.00%
Enable Command and Control	170	170	0.00%
Provide Subsistence	79	79	0.00%
Provide Access to Medical & Health Services	31	31	0.00%
Execute Protection	8	8	0.00%
Provide Access to Maintenance Repair	5	5	0.00%
Totals	**661**	**661**	**0%**

Table C-23: Camp Level Functions, Power Demand (Mean kWh/day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	572	572	0.00%
Enable Command and Control	247	247	0.00%
Provide Subsistence	100	100	0.00%
Provide Access to Medical & Health Services	18	18	0.00%
Execute Protection	8	8	0.00%
Provide Access to Maintenance Repair	5	5	0.00%
Totals	**951**	**951**	**0%**

Table C-24: Equipment Level Functions, Power Demand (Mean kWh/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	788	788	0.00%
Comms and Computers	92	92	0.00%
Lighting	63	63	0.00%
Convenience Loads	47	47	0.00%
Protection	17	17	0.00%
Refrigeration	0	0	0.00%
Totals	**1007**	**1007**	**0%**

Table C-25: Equipment Level Functions, Power Demand (Mean kWh/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	443	443	0.00%
Comms and Computers	92	92	0.00%
Lighting	63	63	0.00%
Convenience Loads	47	47	0.00%
Protection	17	17	0.00%
Refrigeration	0	0	0.00%
Totals	**661**	**661**	**0%**

Table C-26: Equipment Level Functions, Power Demand (Mean kWh/day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	732	732	0.00%
Comms and Computers	92	92	0.00%
Lighting	63	63	0.00%
Convenience Loads	47	47	0.00%
Protection	17	17	0.00%
Refrigeration	0	0	0.00%
Totals	**951**	**951**	**0%**

C.1.6.4 Water Demand Results

Table C-27: Camp Level Functions, Water Demand (Mean gal/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Clean Clothes	46	60	31.25%
Provide Means to Maintain Personal Hygiene	27	35	31.25%
Provide Access to Medical & Health Services	2	3	31.25%
Totals	**75**	**99**	**31%**

Table C-28: Camp Level Functions, Water Demand (Mean gal/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Clean Clothes	46	60	31.25%
Provide Means to Maintain Personal Hygiene	27	35	31.25%
Provide Access to Medical & Health Services	2	3	31.25%
Totals	**75**	**99**	**31%**

Table C-29: Camp Level Functions, Water Demand (Mean gal/day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Clean Clothes	46	60	31.25%
Provide Means to Maintain Personal Hygiene	27	35	31.25%
Provide Access to Medical & Health Services	2	3	31.25%
Totals	**75**	**99**	**31%**

Table C-30: Equipment Level Functions, Water Demand (Mean gal/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Laundry	46	60	31.25%
Hygiene and Showers	29	39	31.25%
Totals	**75**	**99**	**31%**

Table C-31: Equipment Level Functions, Water Demand (Mean gal/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Laundry	46	60	31.25%
Hygiene and Showers	29	39	31.25%
Totals	**75**	**99**	**31%**

Table C-32: Equipment Level Functions, Water Demand (Mean gal/day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Laundry	46	60	31.25%
Hygiene and Showers	29	39	31.25%
Totals	**75**	**99**	**31%**

C.1.6.5 Waste Generation Results

C.1.6.5.1 Waste Water Generation Results

Table C-33: Camp Level Functions, Waste Water Generation (Mean gal/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	27	35	31.25%
Totals	**27**	**35**	**31%**

Table C-34: Camp Level Functions, Waste Water Generation (Mean gal/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	27	35	31.25%
Totals	**27**	**35**	**31%**

Table C-35: Camp Level Functions, Waste Water Generation (Mean gal/day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	27	35	31.25%
Totals	**27**	**35**	**31%**

Table C-36: Equipment Level Functions, Waste Water Generation (Mean gal/day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	27	35	31.25%
Totals	**27**	**35**	**31%**

Table C-37: Equipment Level Functions, Waste Water Generation (Mean gal/day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	27	35	31.25%
Totals	**27**	**35**	**31%**

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	27	35	31.25%
Totals	**27**	**35**	**31%**

C.1.6.5.2 Solid Waste Generation Results

Table C-38: Camp Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	266	349	31.25%
Totals	**266**	**349**	**31%**

Table C-39: Camp Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	266	349	31.25%
Totals	**266**	**349**	**31%**

Table C-40: Camp Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	266	349	31.25%
Totals	**266**	**349**	**31%**

Table C-41: Equipment Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	266	349	31.25%
Totals	**266**	**349**	**31%**

Table C-42: Equipment Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	266	349	31.25%
Totals	**266**	**349**	**31%**

Table C-43: Equipment Level Functions, Solid Waste Generation (lbs./day), 50 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	266	349	31.25%
Totals	**266**	**349**	**31%**

C.2 300 PAX Results

C.2.1 Ready State Results

Table C-44: Camp Level Summary, 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Power Demand (Mean kWh/day)	5108	4091	4806
Fuel Demand (Mean gal/day)	1042	1096	1023
Potable Water Demand (Mean gal/day)	8723	8723	8723
Waste Water Generation (Mean gal/day)	8529	8529	8529
Solid Waste Generation (Mean lbs/day)	2870	2870	2870

C.2.2 Fuel Demand Results

Table C-45: Camp Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Provide Electric Power	937	882	919
Provide Access to Transportation	59	61	59
Provide Access to Maintenance Repair	18	18	18
Execute Protection	13	13	13
Provide Means to Maintain Personal Hygiene	12	34	10
Provide On Base Lighting	3	3	3
Enable Command and Control	0	1	0
Provide Access to MWR Services	0	4	0
Provide Billeting	0	73	0
Provide Subsistence	0	7	0
Totals	**1042**	**1096**	**1023**

Table C-46: Equipment Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Power Generation	937	882	919
On camp Vehicles	59	61	59
Maintenance	18	18	18
Protection	13	13	13
Water Heating	12	22	10
Lighting	3	3	3
Shelter Heating and Cooling	0	96	0
Totals	**1042**	**1096**	**1023**

C.2.3 Power Demand Results

Table C-47: Camp Level Functions, Power Demand (Mean kWh/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Provide Billeting	2402	1422	2203
Provide Subsistence	913	738	895
Enable Command and Control	554	510	556
Provide Means to Maintain Personal Hygiene	428	391	379
Provide Access to MWR Services	302	268	283
Provide Means to Clean Clothes	207	228	207
Provide On Base Lighting	144	144	144
Provide Latrine Services	90	299	77
Provide Access to Maintenance Repair	22	28	19
Provide Access to Medical & Health Services	21	31	18
Execute Protection	14	14	14
Warehouse Store All Supply Classes	13	17	11
Totals	**5108**	**4091**	**4806**

Table C-48: Equipment Level Functions, Power Demand (Mean kWh/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Shelter Heating and Cooling	3045	1927	2728
Lighting	399	399	399
Refrigeration	378	238	395
Convenience Loads	366	366	366
Comms and Computers	344	344	344
Food Prep and Cleaning	282	282	282
Laundry	203	203	203
Water Heating	47	287	44
Water Pumping	27	27	27
Protection	14	14	14
Maintenance	3	3	3
Totals	**5108**	**4091**	**4806**

C.2.4 Water Demand Results

Table C-49: Camp Level Functions, Water Demand (Mean gal/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Provide Means to Maintain Personal Hygiene	4961	4961	4961
Provide Latrine Services	2321	2321	2321
Provide Means to Clean Clothes	751	751	751
Provide Subsistence	370	370	370
Provide Access to Maintenance Repair	312	312	312
Provide Access to Medical & Health Services	8	8	8
Totals	**8723**	**8723**	**8723**

Table C-50: Equipment Level Functions, Water Demand (Mean gal/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Hygiene and Showers	5468	5468	5468
Latrine	1822	1822	1822
Laundry	751	751	751
Food Prep and Cleaning	370	370	370
Maintenance	312	312	312
Totals	**8723**	**8723**	**8723**

C.2.5 Waste Generation Results

C.2.5.1 Waste Water Generation Results

Table C-51: Camp Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Provide Means to Maintain Personal Hygiene	4961	4961	4961
Provide Latrine Services	2447	2447	2447
Provide Means to Clean Clothes	751	751	751
Provide Subsistence	370	370	370
Totals	**8529**	**8529**	**8529**

Table C-52: Equipment Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Hygiene and Showers	5460	5460	5460
Latrine	1948	1948	1948
Laundry	751	751	751
Food Prep and Cleaning	370	370	370
Totals	**8529**	**8529**	**8529**

C.2.5.2 Solid Waste Generation Results

Table C-53: Camp Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Provide Solid Waste Management	2870	2870	2870
Totals	**2870**	**2870**	**2870**

Table C-54: Equipment Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Solid Waste Generation	2870	2870	2870
Totals	**2870**	**2870**	**2870**

C.2.6 Population Variance Results

C.2.6.1 Camp Level Summary Results

Table C-55: Camp Level Summary, 300 PAX, Population Variance, Desert

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	5108	5468	7%
Fuel Demand (Mean gal/day)	1042	1098	5%
Potable Water Demand (Mean gal/day)	8723	11258	29%
Waste Water Generation (Mean gal/day)	8529	11099	30%
Solid Waste Generation (Mean lbs/day)	2870	3735	30%

Table C-56: Camp Level Summary, 300 PAX, Population Variance, Temperate

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	4091	4368	7%
Fuel Demand (Mean gal/day)	1096	1157	6%
Potable Water Demand (Mean gal/day)	8723	11258	29%
Waste Water Generation (Mean gal/day)	8529	11099	30%
Solid Waste Generation (Mean lbs./day)	2870	3735	30%

Table C-57: Camp Level Summary, 300 PAX, Population Variance, Tropical

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	4806	5147	7%
Fuel Demand (Mean gal/day)	1023	1077	5%
Potable Water Demand (Mean gal/day)	8723	11258	29%
Waste Water Generation (Mean gal/day)	8529	11099	30%
Solid Waste Generation (Mean lbs/day)	2870	3735	30%

C.2.6.2 Fuel Demand Results

Table C-58: Camp Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	937	985	5.15%
Provide Access to Transportation	59	63	6.57%
Provide Access to Maintenance Repair	18	18	0.00%
Execute Protection	13	13	0.00%
Provide Means to Maintain Personal Hygiene	12	15	29.76%
Provide On Base Lighting	3	3	0.00%
Enable Command and Control	0	0	N/A
Provide Access to MWR Services	0	0	N/A
Provide Billeting	0	0	N/A
Provide Subsistence	0	0	N/A
Totals	**1042**	**1098**	**5%**

Table C-59: Camp Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	882	926	4.99%
Provide Access to Transportation	61	65	6.51%
Provide Access to Maintenance Repair	18	18	0.00%
Execute Protection	13	13	0.00%
Provide Means to Maintain Personal Hygiene	34	40	19.95%
Provide On Base Lighting	3	3	0.00%
Enable Command and Control	1	1	0.00%
Provide Access to MWR Services	4	4	0.00%
Provide Billeting	73	80	8.70%
Provide Subsistence	7	7	0.00%
Totals	**1096**	**1157**	**6%**

Table C-60: Camp Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	919	967	5.14%
Provide Access to Transportation	59	63	6.57%
Provide Access to Maintenance Repair	18	18	0.00%
Execute Protection	13	13	0.00%
Provide Means to Maintain Personal Hygiene	10	13	29.73%
Provide On Base Lighting	3	3	0.00%
Enable Command and Control	0	0	N/A
Provide Access to MWR Services	0	0	N/A
Provide Billeting	0	0	N/A
Provide Subsistence	0	0	N/A
Totals	**1023**	**1077**	**5%**

Table C-61: Equipment Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	937	985	5.15%
On camp Vehicles	59	63	6.57%
Maintenance	18	18	0.00%
Protection	13	13	0.00%
Water Heating	12	15	29.76%
Lighting	3	3	0.00%
Shelter Heating and Cooling	0	0	N/A
Totals	**1042**	**1098**	**5%**

Table C-62 Equipment Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	882	926	4.99%
On camp Vehicles	61	65	6.51%
Maintenance	18	18	0.00%
Protection	13	13	0.00%
Water Heating	22	29	29.79%
Lighting	3	3	0.00%
Shelter Heating and Cooling	96	103	6.62%
Totals	**1096**	**1157**	**6%**

Table C-63: Equipment Level Functions, Fuel Demand (Mean gal/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	919	967	5.14%
On camp Vehicles	59	63	6.57%
Maintenance	18	18	0.00%
Protection	13	13	0.00%
Water Heating	10	13	29.73%
Lighting	3	3	0.00%
Shelter Heating and Cooling	0	0	N/A
Totals	**1023**	**1077**	**5%**

C.2.6.3 Power Demand Results

Table C-64: Camp Level Functions, Power Demand (Mean kWh/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	2402	2611	8.70%
Provide Subsistence	913	990	8.51%
Enable Command and Control	554	554	0.00%
Provide Means to Maintain Personal Hygiene	428	436	2.06%
Provide Access to MWR Services	302	302	0.00%
Provide Means to Clean Clothes	207	268	29.61%
Provide On Base Lighting	144	144	0.00%
Provide Latrine Services	90	92	2.96%
Provide Access to Maintenance Repair	22	22	0.00%
Provide Access to Medical & Health Services	21	21	0.00%
Execute Protection	14	14	-0.00%
Warehouse Store All Supply Classes	13	13	0.00%
Totals	**5108**	**5468**	**7%**

Table C-65: Camp Level Functions, Power Demand (Mean kWh/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	1422	1546	8.70%
Provide Subsistence	738	816	10.53%
Enable Command and Control	510	510	0.00%
Provide Means to Maintain Personal Hygiene	391	403	3.00%
Provide Access to MWR Services	268	268	0.00%
Provide Means to Clean Clothes	228	289	26.89%
Provide On Base Lighting	144	144	0.00%
Provide Latrine Services	299	302	0.89%
Provide Access to Maintenance Repair	28	28	0.00%
Provide Access to Medical & Health Services	31	31	0.00%
Execute Protection	14	14	-0.00%
Warehouse Store All Supply Classes	17	17	0.00%
Totals	**4091**	**4368**	**7%**

Table C-66: Camp Level Functions, Power Demand (Mean kWh/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	2203	2395	8.70%
Provide Subsistence	895	973	8.68%
Enable Command and Control	556	556	0.00%
Provide Means to Maintain Personal Hygiene	379	387	2.18%
Provide Access to MWR Services	283	283	0.00%
Provide Means to Clean Clothes	207	268	29.62%
Provide On Base Lighting	144	144	0.00%
Provide Latrine Services	77	79	3.46%
Provide Access to Maintenance Repair	19	19	0.00%
Provide Access to Medical & Health Services	18	18	0.00%
Execute Protection	14	14	-0.00%
Warehouse Store All Supply Classes	11	11	0.00%
Totals	**4806**	**5147**	**7%**

Table C-67: Equipment Level Functions, Power Demand (Mean kWh/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	3045	3234	6.19%
Lighting	399	413	3.46%
Refrigeration	378	378	-0.00%
Convenience Loads	366	373	1.81%
Comms and Computers	344	344	0.00%
Food Prep and Cleaning	282	360	27.56%
Laundry	203	264	30.13%
Water Heating	47	50	7.02%
Water Pumping	27	35	30.13%
Protection	14	14	-0.00%
Maintenance	3	3	0.00%
Totals	**5108**	**5468**	**7%**

Table C-68: Equipment Level Functions, Power Demand (Mean kWh/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	1927	2030	5.36%
Lighting	399	413	3.46%
Refrigeration	238	238	0.00%
Convenience Loads	366	373	1.81%
Comms and Computers	344	344	0.00%
Food Prep and Cleaning	282	360	27.56%
Laundry	203	264	30.13%
Water Heating	287	293	2.16%
Water Pumping	27	35	30.13%
Protection	14	14	-0.00%
Maintenance	3	3	0.00%
Totals	**4091**	**4368**	**7%**

Table C-69: Equipment Level Functions, Power Demand (Mean kWh/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	2728	2899	6.27%
Lighting	399	413	3.46%
Refrigeration	395	395	-0.00%
Convenience Loads	366	373	1.81%
Comms and Computers	344	344	0.00%
Food Prep and Cleaning	282	360	27.56%
Laundry	203	264	30.13%
Water Heating	44	46	6.24%
Water Pumping	27	35	30.13%
Protection	14	14	-0.00%
Maintenance	3	3	0.00%
Totals	**4806**	**5147**	**7%**

C.2.6.4 Water Demand Results

Table C-70: Camp Level Functions, Water Demand (Mean gal/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	4961	6455	30.13%
Provide Latrine Services	2321	3021	30.13%
Provide Means to Clean Clothes	751	977	30.13%
Provide Subsistence	370	482	30.13%
Provide Access to Maintenance Repair	312	312	0.00%
Provide Access to Medical & Health Services	8	11	30.13%
Totals	**8723**	**11258**	**29%**

Table C-71: Camp Level Functions, Water Demand (Mean gal/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	4961	6455	30.13%
Provide Latrine Services	2321	3021	30.13%
Provide Means to Clean Clothes	751	977	30.13%
Provide Subsistence	370	482	30.13%
Provide Access to Maintenance Repair	312	312	0.00%
Provide Access to Medical & Health Services	8	11	30.13%
Totals	**8723**	**11258**	**29%**

Table C-72: Camp Level Functions, Water Demand (Mean gal/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	4961	6455	30.13%
Provide Latrine Services	2321	3021	30.13%
Provide Means to Clean Clothes	751	977	30.13%
Provide Subsistence	370	482	30.13%
Provide Access to Maintenance Repair	312	312	0.00%
Provide Access to Medical & Health Services	8	11	30.13%
Totals	**8723**	**11258**	**29%**

Table C-73: Equipment Level Functions, Water Demand (Mean gal/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	5468	7116	30.13%
Latrine	1822	2371	30.13%
Laundry	751	977	30.13%
Food Prep and Cleaning	370	482	30.13%
Maintenance	312	312	0.00%
Totals	**8723**	**11258**	**29%**

Table C-74: Equipment Level Functions, Water Demand (Mean gal/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	5468	7116	30.13%
Latrine	1822	2371	30.13%
Laundry	751	977	30.13%
Food Prep and Cleaning	370	482	30.13%
Maintenance	312	312	0.00%
Totals	**8723**	**11258**	**29%**

Table C-75: Equipment Level Functions, Water Demand (Mean gal/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	5468	7116	30.13%
Latrine	1822	2371	30.13%
Laundry	751	977	30.13%
Food Prep and Cleaning	370	482	30.13%
Maintenance	312	312	0.00%
Totals	**8723**	**11258**	**29%**

C.2.6.5 Waste Generation Results

C.2.6.5.1 Waste Water Generation Results

Table C-76: Camp Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	4961	6455	30.13%
Provide Latrine Services	2447	3185	30.13%
Provide Means to Clean Clothes	751	977	30.13%
Provide Subsistence	370	482	30.13%
Totals	**8529**	**11099**	**30%**

Table C-77: Camp Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	4961	6455	30.13%
Provide Latrine Services	2447	3185	30.13%
Provide Means to Clean Clothes	751	977	30.13%
Provide Subsistence	370	482	30.13%
Totals	**8529**	**11099**	**30%**

Table C-78: Camp Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	4961	6455	30.13%
Provide Latrine Services	2447	3185	30.13%
Provide Means to Clean Clothes	751	977	30.13%
Provide Subsistence	370	482	30.13%
Totals	**8529**	**11099**	**30%**

Table C-79: Equipment Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	5460	7105	30.13%
Latrine	1948	2535	30.13%
Laundry	751	977	30.13%
Food Prep and Cleaning	370	482	30.13%
Totals	**8529**	**11099**	**30%**

Table C-80: Equipment Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	5460	7105	30.13%
Latrine	1948	2535	30.13%
Laundry	751	977	30.13%
Food Prep and Cleaning	370	482	30.13%
Totals	**8529**	**11099**	**30%**

Table C-81: Equipment Level Functions, Waste Water Generation (Mean gal/day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	5460	7105	30.13%
Latrine	1948	2535	30.13%
Laundry	751	977	30.13%
Food Prep and Cleaning	370	482	30.13%
Totals	**8529**	**11099**	**30%**

C.2.6.5.2 Solid Waste Generation Results

Table C-82: Camp Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	2870	3735	30.13%
Totals	**2870**	**3735**	**30%**

Table C-83: Camp Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	2870	3735	30.13%
Totals	**2870**	**3735**	**30%**

Table C-84: Camp Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	2870	3735	30.13%
Totals	**2870**	**3735**	**30%**

Table C-85: Equipment Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	2870	3735	30.13%
Totals	**2870**	**3735**	**30%**

Table C-86: Equipment Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	2870	3735	30.13%
Totals	**2870**	**3735**	**30%**

Table C-87: Equipment Level Functions, Solid Waste Generation (lbs./day), 300 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	2870	3735	30.13%
Totals	**2870**	**3735**	**30%**

C.3 1000 PAX Results

C.3.1 Ready State Results

Table C-88: Camp Level Summary, 1000 PAX, Ready State

Resource Type	Desert	Temperate	Tropical
Power Demand (Mean kWh/day)	17580	14751	16463
Fuel Demand (Mean gal/day)	3376	3654	3301
Potable Water Demand (Mean gal/day)	31305	31305	31305
Waste Water Generation (Mean gal/day)	31153	31153	31153
Solid Waste Generation (Mean lbs./day)	10672	10672	10672

C.3.2 Fuel Demand Results

Table C-89: Camp Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Electric Power	3042	2892	2979
Provide Access to Transportation	182	186	182
Provide Subsistence	45	59	45
Provide Means to Maintain Personal Hygiene	44	139	37
Provide On Base Lighting	28	28	28
Execute Protection	26	26	26
Provide Access to Maintenance Repair	9	65	3
Enable Command and Control	0	3	0
Enable Movement Maneuver	0	7	0
Provide Access to MWR Services	0	14	0
Provide Billeting	0	229	0
Provide Means to Clean Clothes	0	3	0
Warehouse Store All Supply Classes	0	4	0
Totals	**3376**	**3654**	**3301**

Table C-90: Equipment Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Power Generation	3042	2892	2979
On camp Vehicles	182	186	182
Food Prep and Cleaning	45	45	45
Water Heating	44	84	37
Lighting	28	28	28
Protection	26	26	26
Maintenance	3	3	3
Shelter Heating and Cooling	5	391	0
Totals	**3376**	**3654**	**3301**

C.3.3 Power Demand Results

Table C-91: Camp Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Billeting	7626	4606	6986
Enable Command and Control	2326	2256	2338
Provide Means to Maintain Personal Hygiene	2100	1907	1858
Provide Access to MWR Services	1697	1563	1621
Provide Subsistence	1425	944	1397
Provide Means to Clean Clothes	816	921	804
Provide On Base Lighting	420	420	420
Provide Latrine Services	438	1484	373
Execute Protection	263	263	263
Enable Movement Maneuver	203	126	169
Warehouse Store All Supply Classes	117	79	100
Provide Access to Maintenance Repair	101	114	97
Provide Access to Medical & Health Services	43	63	36
Enable Communications	4	5	3
Totals	**17580**	**14751**	**16463**

Table C-92: Equipment Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Shelter Heating and Cooling	10663	7203	9516
Convenience Loads	1704	1704	1704
Comms and Computers	1448	1448	1448
Lighting	1399	1399	1399
Laundry	720	720	720
Refrigeration	622	295	663
Protection	427	427	427
Food Prep and Cleaning	266	266	266
Water Heating	218	1176	207
Water Pumping	102	102	102
Maintenance	9	9	9
Totals	**17580**	**14751**	**16463**

C.3.4 Water Demand Results

Table C-93: Camp Level Functions, Water Demand (Mean gal/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Means to Maintain Personal Hygiene	18444	18444	18444
Provide Latrine Services	8855	8855	8855
Provide Means to Clean Clothes	2712	2712	2712
Provide Subsistence	654	654	654
Provide Access to Maintenance Repair	624	624	624
Provide Access to Medical & Health Services	17	17	17
Totals	**31305**	**31305**	**31305**

Table C-94: Equipment Level Functions, Water Demand (Mean gal/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Hygiene and Showers	20317	20317	20317
Latrine	6999	6999	6999
Laundry	2712	2712	2712
Food Prep and Cleaning	654	654	654
Maintenance	624	624	624
Totals	**31305**	**31305**	**31305**

C.3.5 Waste Generation Results

C.3.5.1 Waste Water Generation Results

Table C-95: Camp Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Means to Maintain Personal Hygiene	18444	18444	18444
Provide Latrine Services	9327	9327	9327
Provide Means to Clean Clothes	2712	2712	2712
Provide Subsistence	654	654	654
Provide Access to Medical & Health Services	17	17	17
Totals	**31153**	**31153**	**31153**

Table C-96: Equipment Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Hygiene and Showers	20317	20317	20317
Latrine	7471	7471	7471
Laundry	2712	2712	2712
Food Prep and Cleaning	654	654	654
Totals	**31153**	**31153**	**31153**

C.3.5.2 Solid Waste Generation Results

Table C-97: Camp Level Functions, Solid Waste Generation (lbs./day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Provide Solid Waste Management	10672	10672	10672
Totals	**10672**	**10672**	**10672**

Table C-98: Equipment Level Functions, Solid Waste Generation (lbs/day), 1000 PAX, Ready State

Functional Areas	Desert	Temperate	Tropical
Solid Waste Generation	10672	10672	10672
Totals	**10672**	**10672**	**10672**

C.3.6 Population Variance Results

C.3.6.1 Camp Level Summary Results

Table C-99: Camp Level Summary, 1000 PAX, Population Variance, Desert

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	17580	18327	4%
Fuel Demand (Mean gal/day)	3376	3498	4%
Potable Water Demand (Mean gal/day)	31305	40061	28%
Waste Water Generation (Mean gal/day)	31153	40044	29%
Solid Waste Generation (Mean lbs/day)	10672	13717	29%

Table C-100: Camp Level Summary, 1000 PAX, Population Variance, Temperate

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	14751	15343	4%
Fuel Demand (Mean gal/day)	3654	3792	4%
Potable Water Demand (Mean gal/day)	31305	40061	28%
Waste Water Generation (Mean gal/day)	31153	40044	29%
Solid Waste Generation (Mean lbs/day)	10672	13717	29%

Table C-101: Camp Level Summary, 1000 PAX, Population Variance, Tropical

Resource Type	Baseline	Population Variance	Percent Change
Power Demand (Mean kWh/day)	16463	17171	4%
Fuel Demand (Mean gal/day)	3301	3418	4%
Potable Water Demand (Mean gal/day)	31305	40061	28%
Waste Water Generation (Mean gal/day)	31153	40044	29%
Solid Waste Generation (Mean lbs./day)	10672	13717	29%

C.3.6.2. Fuel Demand Results

Table C-102: Camp Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	3042	3110	2.23%
Provide Access to Transportation	182	210	15.53%
Provide Subsistence	45	58	28.53%
Provide Means to Maintain Personal Hygiene	44	57	28.06%
Provide On Base Lighting	28	28	0.00%
Execute Protection	26	26	0.00%
Provide Access to Maintenance Repair	9	9	0.00%
Enable Command and Control	0	0	N/A
Enable Movement Maneuver	0	0	N/A
Provide Access to MWR Services	0	0	N/A
Provide Billeting	0	0	N/A
Provide Means to Clean Clothes	0	0	N/A
Warehouse Store All Supply Classes	0	0	N/A
Totals	**3376**	**3498**	**4%**

Table C-103: Camp Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	2892	2952	2.07%
Provide Access to Transportation	186	214	15.30%
Provide Subsistence	59	72	21.72%
Provide Means to Maintain Personal Hygiene	139	163	16.92%
Provide On Base Lighting	28	28	0.00%
Execute Protection	26	26	0.00%
Provide Access to Maintenance Repair	65	65	0.00%
Enable Command and Control	3	3	0.00%
Enable Movement Maneuver	7	7	0.00%
Provide Access to MWR Services	14	14	0.00%
Provide Billeting	229	242	5.56%
Provide Means to Clean Clothes	3	3	0.00%
Warehouse Store All Supply Classes	4	4	0.00%
Totals	**3654**	**3792**	**4%**

Table C-104: Camp Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Electric Power	2979	3045	2.21%
Provide Access to Transportation	182	210	15.51%
Provide Subsistence	45	58	28.53%
Provide Means to Maintain Personal Hygiene	37	47	28.03%
Provide On Base Lighting	28	28	0.00%
Execute Protection	26	26	0.00%
Provide Access to Maintenance Repair	3	3	0.00%
Enable Command and Control	0	0	N/A
Enable Movement Maneuver	0	0	N/A
Provide Access to MWR Services	0	0	N/A
Provide Billeting	0	0	N/A
Provide Means to Clean Clothes	0	0	N/A
Warehouse Store All Supply Classes	0	0	N/A
Totals	**3301**	**3418**	**4%**

Table C-105: Equipment Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	3042	3110	2.23%
On camp Vehicles	182	210	15.53%
Food Prep and Cleaning	45	58	28.53%
Water Heating	44	57	28.06%
Lighting	28	28	0.00%
Protection	26	26	0.00%
Maintenance	3	3	0.00%
Shelter Heating and Cooling	5	5	0.00%
Totals	**3376**	**3498**	**4%**

Table C-106: Equipment Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	2892	2952	2.07%
On camp Vehicles	186	214	15.30%
Food Prep and Cleaning	45	58	28.53%
Water Heating	84	107	28.11%
Lighting	28	28	0.00%
Protection	26	26	0.00%
Maintenance	3	3	0.00%
Shelter Heating and Cooling	391	404	3.26%
Totals	**3654**	**3792**	**4%**

Table C-107: Equipment Level Functions, Fuel Demand (Mean gal/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Power Generation	2979	3045	2.21%
On camp Vehicles	182	210	15.51%
Food Prep and Cleaning	45	58	28.53%
Water Heating	37	47	28.03%
Lighting	28	28	0.00%
Protection	26	26	0.00%
Maintenance	3	3	0.00%
Shelter Heating and Cooling	0	0	N/A
Totals	**3301**	**3418**	**4%**

C.3.6.3 Power Demand Results

Table C-108: Camp Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	7626	8078	5.93%
Enable Command and Control	2326	2326	-0.00%
Provide Means to Maintain Personal Hygiene	2100	2131	1.48%
Provide Access to MWR Services	1697	1697	0.00%
Provide Subsistence	1425	1474	3.40%
Provide Means to Clean Clothes	816	1021	25.18%
Provide On Base Lighting	420	420	0.00%
Provide Latrine Services	438	448	2.19%
Execute Protection	263	263	0.00%
Enable Movement Maneuver	203	203	0.00%
Warehouse Store All Supply Classes	117	117	0.00%
Provide Access to Maintenance Repair	101	101	-0.00%
Provide Access to Medical & Health Services	43	43	0.32%
Enable Communications	4	4	0.00%
Totals	**17580**	**18327**	**4%**

Table C-109: Camp Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	4606	4893	6.24%
Enable Command and Control	2256	2256	-0.00%
Provide Means to Maintain Personal Hygiene	1907	1948	2.17%
Provide Access to MWR Services	1563	1563	0.00%
Provide Subsistence	944	993	5.13%
Provide Means to Clean Clothes	921	1126	22.31%
Provide On Base Lighting	420	420	0.00%
Provide Latrine Services	1484	1493	0.65%
Execute Protection	263	263	0.00%
Enable Movement Maneuver	126	126	0.00%
Warehouse Store All Supply Classes	79	79	0.00%
Provide Access to Maintenance Repair	114	114	0.00%
Provide Access to Medical & Health Services	63	63	0.22%
Enable Communications	5	5	-0.00%
Totals	**14751**	**15343**	**4%**

Table C-110: Camp Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Billeting	6986	7402	5.95%
Enable Command and Control	2338	2338	0.00%
Provide Means to Maintain Personal Hygiene	1858	1887	1.57%
Provide Access to MWR Services	1621	1621	0.00%
Provide Subsistence	1397	1446	3.47%
Provide Means to Clean Clothes	804	1009	25.56%
Provide On Base Lighting	420	420	0.00%
Provide Latrine Services	373	383	2.57%
Execute Protection	263	263	0.00%
Enable Movement Maneuver	169	169	0.00%
Warehouse Store All Supply Classes	100	100	0.00%
Provide Access to Maintenance Repair	97	97	0.00%
Provide Access to Medical & Health Services	36	36	0.38%
Enable Communications	3	3	0.00%
Totals	**16463**	**17171**	**4%**

Table C-111: Equipment Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	10663	11067	3.79%
Convenience Loads	1704	1718	0.82%
Comms and Computers	1448	1448	-0.00%
Lighting	1399	1434	2.47%
Laundry	720	925	28.53%
Refrigeration	622	622	0.00%
Protection	427	427	0.00%
Food Prep and Cleaning	266	315	18.18%
Water Heating	218	229	5.28%
Water Pumping	102	132	28.54%
Maintenance	9	9	0.00%
Totals	**17580**	**18327**	**4%**

Table C-112: Equipment Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	7203	7442	3.31%
Convenience Loads	1704	1718	0.82%
Comms and Computers	1448	1448	-0.00%
Lighting	1399	1434	2.47%
Laundry	720	925	28.53%
Refrigeration	295	295	0.00%
Protection	427	427	0.00%
Food Prep and Cleaning	266	315	18.18%
Water Heating	1176	1198	1.85%
Water Pumping	102	132	28.54%
Maintenance	9	9	0.00%
Totals	**14751**	**15343**	**4%**

Table C-113: Equipment Level Functions, Power Demand (Mean kWh/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Shelter Heating and Cooling	9516	9883	3.86%
Convenience Loads	1704	1718	0.82%
Comms and Computers	1448	1448	-0.00%
Lighting	1399	1434	2.47%
Laundry	720	925	28.53%
Refrigeration	663	663	0.00%
Protection	427	427	0.00%
Food Prep and Cleaning	266	315	18.18%
Water Heating	207	217	4.64%
Water Pumping	102	132	28.54%
Maintenance	9	9	0.00%
Totals	**16463**	**17171**	**4%**

C.3.6.4 Water Demand Results

Table C-114: Camp Level Functions, Water Demand (Mean gal/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	18444	23707	28.53%
Provide Latrine Services	8855	11383	28.55%
Provide Means to Clean Clothes	2712	3486	28.53%
Provide Subsistence	654	840	28.53%
Provide Access to Maintenance Repair	624	624	0.00%
Provide Access to Medical & Health Services	17	21	28.53%
Totals	**31305**	**40061**	**28%**

Table C-115: Camp Level Functions, Water Demand (Mean gal/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	18444	23707	28.53%
Provide Latrine Services	8855	11383	28.55%
Provide Means to Clean Clothes	2712	3486	28.53%
Provide Subsistence	654	840	28.53%
Provide Access to Maintenance Repair	624	624	0.00%
Provide Access to Medical & Health Services	17	21	28.53%
Totals	**31305**	**40061**	**28%**

Table C-116: Camp Level Functions, Water Demand (Mean gal/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	18444	23707	28.53%
Provide Latrine Services	8855	11383	28.55%
Provide Means to Clean Clothes	2712	3486	28.53%
Provide Subsistence	654	840	28.53%
Provide Access to Maintenance Repair	624	624	0.00%
Provide Access to Medical & Health Services	17	21	28.53%
Totals	**31305**	**40061**	**28%**

Table C-117: Equipment Level Functions, Water Demand (Mean gal/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	20317	26114	28.53%
Latrine	6999	8998	28.55%
Laundry	2712	3486	28.53%
Food Prep and Cleaning	654	840	28.53%
Maintenance	624	624	0.00%
Totals	**31305**	**40061**	**28%**

Table C-118: Equipment Level Functions, Water Demand (Mean gal/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	20317	26114	28.53%
Latrine	6999	8998	28.55%
Laundry	2712	3486	28.53%
Food Prep and Cleaning	654	840	28.53%
Maintenance	624	624	0.00%
Totals	**31305**	**40061**	**28%**

Table C-119: Equipment Level Functions, Water Demand (Mean gal/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	20317	26114	28.53%
Latrine	6999	8998	28.55%
Laundry	2712	3486	28.53%
Food Prep and Cleaning	654	840	28.53%
Maintenance	624	624	0.00%
Totals	**31305**	**40061**	**28%**

C.3.6.5 Waste Generation Results

C.3.6.5.1 Waste Water Generation Results

Table C-120: Camp Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	18444	23707	28.53%
Provide Latrine Services	9327	11990	28.55%
Provide Means to Clean Clothes	2712	3486	28.53%
Provide Subsistence	654	840	28.53%
Provide Access to Medical & Health Services	17	21	28.53%
Totals	**31153**	**40044**	**29%**

Table C-121: Camp Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	18444	23707	28.53%
Provide Latrine Services	9327	11990	28.55%
Provide Means to Clean Clothes	2712	3486	28.53%
Provide Subsistence	654	840	28.53%
Provide Access to Medical & Health Services	17	21	28.53%
Totals	**31153**	**40044**	**29%**

Table C-122: Camp Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Means to Maintain Personal Hygiene	18444	23707	28.53%
Provide Latrine Services	9327	11990	28.55%
Provide Means to Clean Clothes	2712	3486	28.53%
Provide Subsistence	654	840	28.53%
Provide Access to Medical & Health Services	17	21	28.53%
Totals	**31153**	**40044**	**29%**

Table C-123: Equipment Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	20317	26114	28.53%
Latrine	7471	9604	28.55%
Laundry	2712	3486	28.53%
Food Prep and Cleaning	654	840	28.53%
Totals	**31153**	**40044**	**29%**

Table C-124: Equipment Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	20317	26114	28.53%
Latrine	7471	9604	28.55%
Laundry	2712	3486	28.53%
Food Prep and Cleaning	654	840	28.53%
Totals	**31153**	**40044**	**29%**

Table C-125: Equipment Level Functions, Waste Water Generation (Mean gal/day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Hygiene and Showers	20317	26114	28.53%
Latrine	7471	9604	28.55%
Laundry	2712	3486	28.53%
Food Prep and Cleaning	654	840	28.53%
Totals	**31153**	**40044**	**29%**

C.3.6.5.2 Solid Waste Generation Results

Table C-126: Camp Level Functions, Solid Waste Generation (lbs./day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	10672	13717	28.53%
Totals	**10672**	**13717**	**29%**

Table C--127: Camp Level Functions, Solid Waste Generation (lbs./day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	10672	13717	28.53%
Totals	**10672**	**13717**	**29%**

Table C-128: Camp Level Functions, Solid Waste Generation (lbs./day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Provide Solid Waste Management	10672	13717	28.53%
Totals	**10672**	**13717**	**29%**

Table C-129: Equipment Level Functions, Solid Waste Generation (lbs./day), 1000 PAX, Population Variance, Desert

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	10672	13717	28.53%
Totals	**10672**	**13717**	**29%**

Table C-130: Equipment Level Functions, Solid Waste Generation (lbs./day), 1000 PAX, Population Variance, Temperate

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	10672	13717	28.53%
Totals	**10672**	**13717**	**29%**

Table C-131: Equipment Level Functions, Solid Waste Generation (lbs./day), 1000 PAX, Population Variance, Tropical

Functional Areas	Baseline	Population Variance	Percent Change
Solid Waste Generation	10672	13717	28.53%
Totals	**10672**	**13717**	**29%**

ANNEX D – FY12 ORTB System Configuration, Equipment List, and Operational View, By Basecamp Size

DCAM Input	Reference File Name
50 PAX Ready State and Population Variance System Configuration	50_PAX_System_Configuration_ORTBv1-2_v1-0.xls
50 PAX Ready State and Population Variance Equipment List	50_PAX_Equipment_List_ORTBv1-2_v1-0.xls
50 PAX Ready State Operational View File	50_PAX_Operational_View_ORTBv1-2_v1-0.xlsx
50 PAX Population Variance Operational View File	50_PAX_Op_View_Variant_ORTBv1-2-PopVariance_v1-0.xlsx
300 PAX Ready State System Configuration	300_PAX_System_Configuration_ORTBv1-2_v1-0.xls
300 PAX Ready State Equipment List	300_PAX_Equipment_List_ORTBv1-2_v1-0.xls
300 PAX Ready State Operational View File	300_PAX_Operational_View_ORTBv1-2_v1-0.xlsx
300 PAX Population Variance System Configuration	300_PAX_System_Configuration_ORTBv1-2-PopVariance_v1-0.xls
300 PAX Population Variance Equipment List	300_PAX_Equipment_List_ORTBv1-2-PopVariance_v1-0.xls
300 PAX Population Variance Operational View File	300_PAX_Op_View_Variant_ORTBv1-2-PopVariance_v1-0.xlsx
1000 PAX Ready State System Configuration	1000_PAX_System_Configuration_ORTBv1-2_v1-1.xls
1000 PAX Ready State Equipment List	1000_PAX_Equipment_List_ORTBv1-2_v1-1.xls
1000 PAX Ready State Operational View File	1000_PAX_Operational_View_ORTBv1-2_v1-0.xlsx
1000 PAX Population Variance System Configuration	1000_PAX_System_Configuration_ORTBv1-2-PopVariance_v1-1.xls
1000 PAX Population Variance Equipment List	1000_PAX_Equipment_List_ORTBv1-2-PopVariance_v1-1.xls
1000 PAX Population Variance Operational View File	1000_PAX_Op_View_Variant_ORTBv1-2-PopVariance_v1-0.xlsx
DCAM Version	0.21
Component Database	MSAT_CDB_Database_v1-3D_C.db
Profile File	Profiles_Database_v1-0.xlsx
Lookup Database	MSAT_CDB_AMSAALookup_v1-0D_C.db

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ANNEX E – REQUESTING DATA, DOCUMENTATION AND TOOLS

(reprint of original)

Fill in the following application.

US Army Natick Soldier Research, Development, and Engineering Center (NSRDEC)
Expeditionary Basing and Collective Protection Directorate (EBCP)
Natick, MA

Sustainability/Logistics-Basing, Science and Technology Objective Demonstration (Formerly TECD-4a)

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10. To the extent of its knowledge and belief, the requesting U.S. contractor knows of no person employed by it, or acting on its behalf, who will have access to this data, who is debarred, suspended, or otherwise ineligible from performing on U.S. Government contracts; or has violated U.S. export control laws.

11. The U.S. contractor itself is not debarred, suspended or otherwise determined ineligible by any agency of the U.S. Government to perform on U.S. Government contracts, has not been convicted of export control law violations, and has not been disqualified under the provisions of DoD Directive 5230.25.

12. The U.S. contractor acknowledges that below **data items** only are provided under this agreement.

LISTING OF NSRDEC – DATA and/or Work Product COVERED BY THIS AGREEMENT:

1)
2)
3)
4)

ADDITIONAL COTS/GOTS PROVIDED FOR LISTED DATA ABOVE: The following items have been provided with the data.

COTS/GOTS: **None**

ESTIMATED COMPLETION DATE: **N/A**

PURPOSE: (Clearly identify the intended purpose/use of the material plus impact of not receiving material).

The above listed data items are being provided for the purpose of _____

Processing or analysis of the data items will be distributed ONLY to _____

REQUESTING ORGANIZATION NAME: _____

REQUESTING ORGANIZATION AUTHORIZED POINT OF CONTACT (POC):

NAME (Print): _____ DATE: _____

TELEPHONE: _____ E-MAIL:_____

ORGANIZATION: _____

I HEREBY AGREE TO CONDITIONS 1-12 IDENTIFIED ON PAGE 1 OF THIS DOCUMENT AND WILL UTILIZE THE DATA MATERIAL ONLY FOR THE PURPOSE/USE DESCRIBED ABOVE. I UNDERSTAND THAT PROCESSING OR TRANSMITTING THIS EXPORT CONTROLLED DATA MATERIAL VIA ANY PUBLIC ELECTRONIC MEDIUM IS STRICTLY PROHIBITED.

SIGNATURE: _____

REQUEST FOR RELEASE TO U.S. CONTRACTOR: (To Be Completed by DoD Sponsoring Organization COR or other authorized individual). It is requested that the NSRDEC – SLB-STO-D, data material be released to the above-identified contractor for the purpose as stated. It is hereby certified that the contract number and completion date identified above are correct and the identified contractor requires the software material for the purpose stated.

Date: _____

Name (Please Print): Ben Campbell

Position: _____Lead Systems Engineer

Telephone: (508) 233-5451 E-mail: benjamin.j.campbell26.civ.civ@mail.mil

Authorized Signature: _____

U.S. GOVERNMENT SPONSOR APPROVAL: The above request is approved for the purpose stated by the requester.

_____

(NSRDEC – SLB-STO-D) (Date)

NAME: Gregg Gildea